

✧ CENTENNIAL EDITION ✧

# AIR & SPACE

Smithsonian

MARCH 2003

## 100 YEARS *of* FLIGHT

MEET THE WRIGHT BROTHERS ✧ SEE ALL THEIR AIRPLANES (THERE WERE 19!) ✧ PLUS ✧ DEFINING MOMENTS: HOW O-RINGS CHANGED AVIATION AND THE DC-3 LED THE WAY TO THE FUTURE  
10 GREAT PILOTS ✧ 10 MILESTONE FLIGHTS ✧ 100 WAYS TO CELEBRATE



Photo courtesy of Burton "Bud" C. Cook family



Smithsonian  
National Air and Space Museum

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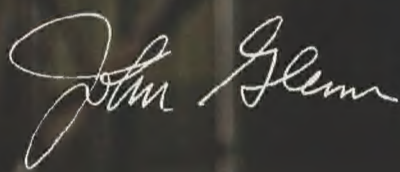
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Secretary General, Inventing Flight



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## INVENTING FLIGHT

### DAYTON 2003

THE CENTENNIAL CELEBRATION



Standard Register

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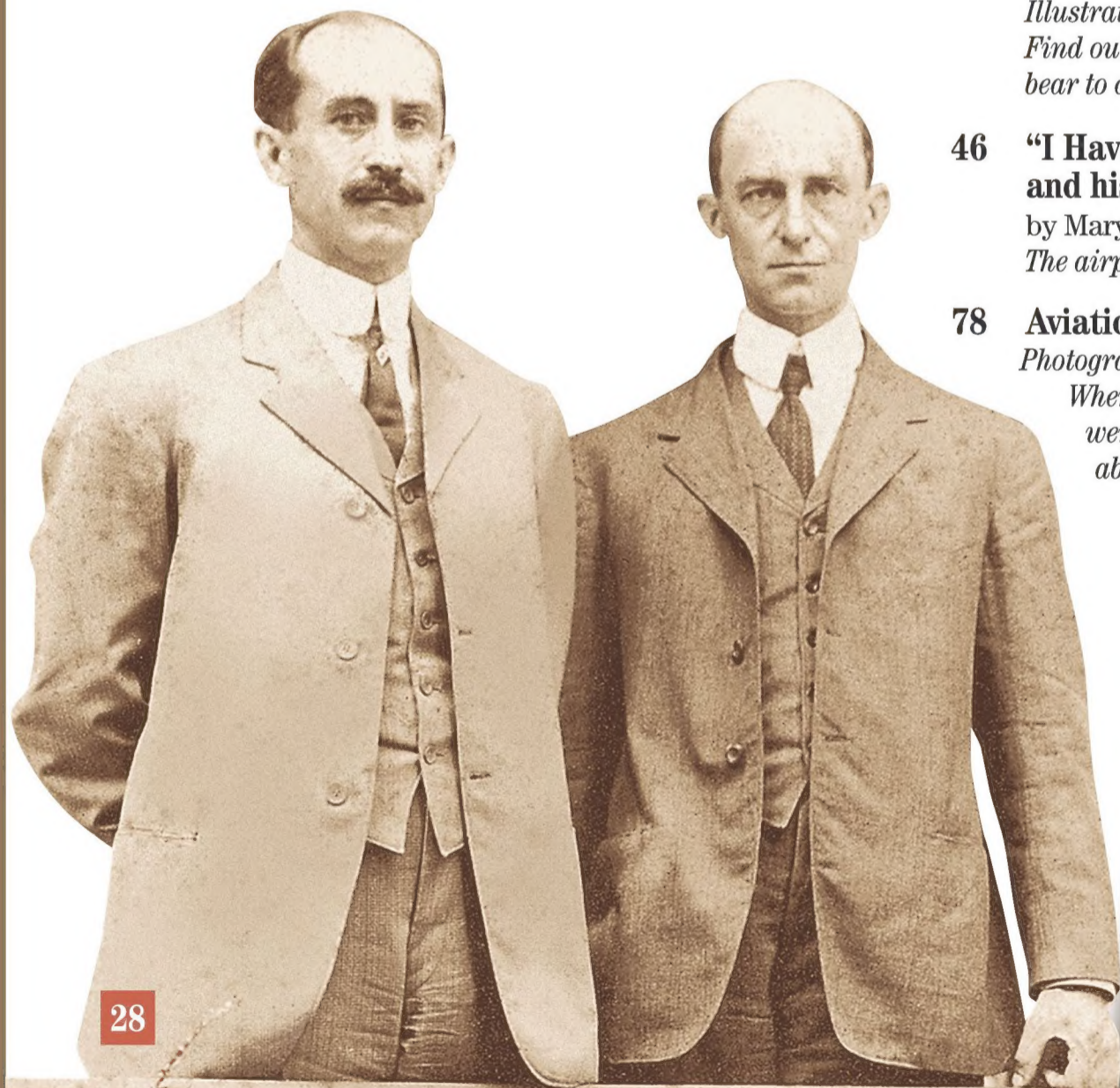
Dayton Daily News

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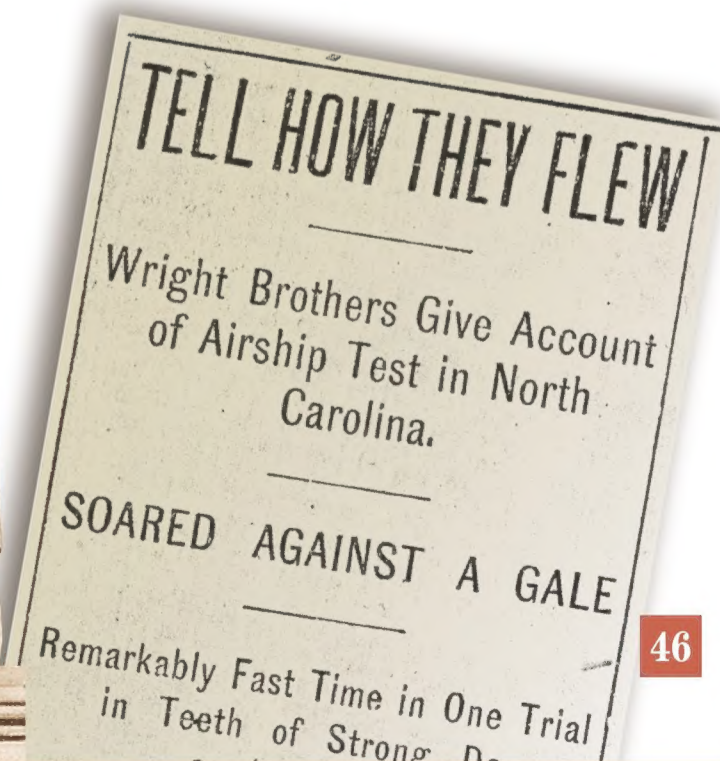
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# AIR & SPACE

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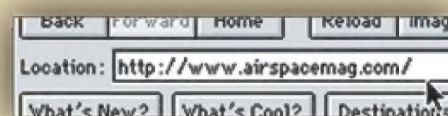
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**Cover:** Peering from its hangar in Hans Groenhoff's 1938 photo, a DC-3 appears to see a future when its descendants will fly 3 million passengers a day at 570 mph to every spot on the globe.

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## Celebrate With Us

One hundred years ago, the Wright brothers gave the gift of flight to the world, and throughout 2003, the United States and other nations will commemorate and reflect upon the meaning of their invention. On December 17, 1903, Orville and Wilbur Wright made history on the barren windswept dunes of North Carolina's outer banks. The two brothers from Ohio were dressed in coats and ties—the fashion of the day—even as they worked in the blowing sand, preparing their hand-made craft, with its wings of fabric-covered wood and its hand-carved propellers, for a test.

In the first attempt, with Orville at the controls, the airplane flew for 12 seconds and traveled 120 feet. The brothers made three more flights that day, and on the last attempt, Wilbur flew for 59 seconds and covered 852 feet (see "The Original," p. 34). The Wrights had succeeded where all others had failed, launching the industry that, more than any other, defined the 20th century. In doing so, they entered history's hall of achievement.

Throughout 2003 the United States Centennial of Flight Commission will coordinate with the programs of its partners and others to commemorate the success of the Wrights and a century of flight. As chair of the commission, I am honored to be part of this celebration.

Flight has fundamentally reshaped our world and has had a profound effect on the human condition. At the National Air and Space Museum, several important activities are under way to reconsider the importance of the technology of flight. Most important, the Museum is building the Steven F. Udvar-Hazy Center at Washington Dulles International

Airport in Virginia to provide much-needed space for objects that tell the history of flight but have been too large for display on the National Mall. This 760,057-square-foot building will be situated on 176.5 acres, and includes exhibit hangars, a tower from which visitors can watch air traffic at Dulles, collections storage, classrooms, archives, a large-format theater, restaurants, and gift shops. Over 200 aircraft and 135 spacecraft will be on display, including the space shuttle *Enterprise*, an SR-71 Blackbird reconnaissance aircraft, the prototype of the Boeing 707, a B-17 bomber, an F-4 Phantom II fighter, and the B-29 Superfortress *Enola Gay*. Scheduled to open on December 15, 2003, two days before the centennial of the first powered flight, the Center promises to thrill aerospace enthusiasts and educate and inspire all who visit it.

We also have a major exhibit under way: "The Wright Brothers & the Invention of the Aerial Age" offers an imaginative presentation of the Wrights' achievement paired with the cultural impact of flight in the decade after 1903. It juxtaposes the history of invention with a rich examination of how this revolutionary technology was received, understood, and speculated upon.

Furthermore, when the exhibition opens in October 2003, it will show for the first time the Wright *Flyer*, currently hanging in our Milestones of Flight gallery, at eye level so that visitors can view it close up.

Join with us as we commemorate this epoch and look toward the future.

—J.R. Dailey is the director of the National Air and Space Museum.

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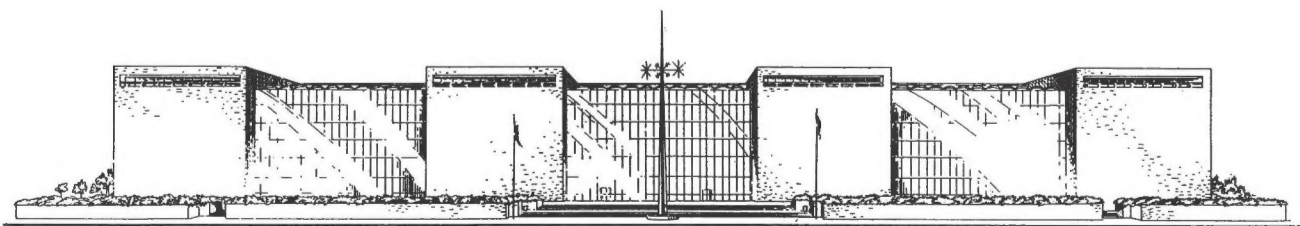
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## LETTERS

### Tunnel Visionaries

"The Man Who Could See Air" (June/July 2002) nicely portrayed Richard Whitcomb's career at NASA's Langley Research Center in Virginia but mischaracterized Langley's late-1940s invention of transonic wind tunnels.

Langley research engineers had long known that solving transonic trickiness would require precisely sculpting openings in the walls of a tunnel's test section. Hands-on "filler and file" work did eventually help, but the fundamental unlocking of the problem was accomplished by Ray H. Wright, whose mathematical analysis specified a few evenly distributed longitudinal slots.

The overall achievement earned history's only Collier Trophy for an Earth-bound research tool; it was awarded to Langley research manager John Stack and 19 associates, including Wright and Whitcomb.

Such researchers made mid-century Langley resemble Cremona, Italy, in the violin-making era of Antonio Stradivari. In both technical cultures, scientific craftsmen engineered instruments to move air.

Steven T. Corneliusen  
 Poquoson, Virginia

### Airy Tale

"Russian Revolution" (Apr./May 2002) mentioned "introducing nitrogen compressed to 750 pounds per square inch" to help start the engine without electrical power. It has to be compressed air, not nitrogen.

Years ago, when I was working on prop aircraft at a little airport in Orange County, New York, I had the opportunity to work on Ian Groom's Su-31. Ian had just moved up from his little Pitts, which I had also worked on. After I did some engine work, we tried to start the Su-31 for a test run. We had only enough compressed air for two start attempts. Both failed, leaving the air tank empty. The only high-pressure gas left was our bottled nitrogen. We used that to try to start the engine, but failed yet again. Then it dawned on me that nitrogen is inert and thus will not support combustion. Of course it wouldn't start!

When Ian showed up, we told him of our plight and he said he had a small scuba tank that he would use to service the aircraft starting bottle. The only place that had compressors with high enough pressure was the local dive shop.

A dive shop will not fill a scuba tank without a certification card. I happen to be a diver, and I had my card with me. I loaned it to Ian so he could fill up his scuba tank and start his aircraft. Once we had compressed air in the cylinders with Ian at the controls, the engine started.

Timothy Kowles  
 Pine Bush, New York

### Fueling Around

I am in the Air Force and assigned to Edwards Air Force Base as a flight test boom operator, so I was excited to see the cover of the Dec. 2002/Jan. 2003 issue, as I have refueled the X-35 many times.

By the way, "Yawning Across the Atlantic" (Above & Beyond, same issue) could only have been written by a pilot, because he did not make any mention of how the fighter pilots' skill at aerial refueling diminishes greatly as the flight progresses. That's why the fighters try to stop refueling as soon as possible and press on to their final destination. We often tease the fighter types as we drone along:

"Hey, did you guys see that?" we say.

"See what?" they say.

"Well, I got my lunch, read the paper, went to the bathroom *in the bathroom*, and stretched my legs."

And with that, the radios remain rather silent.

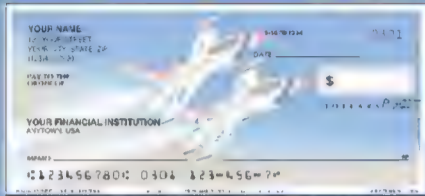
TSgt. Dave Francey  
 Edwards Air Force Base, California

### The Things We Did at Nellis

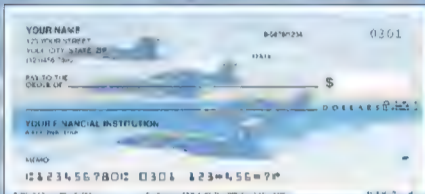
"Air Combat U" (Dec. 2001/Jan. 2002) was the most accurate and most thrilling story that I have read in a long time about the things we did at Nellis Air Force Base in the 1950s. I flew the F-100 for the first time in July 1957 and had some of the same experiences that author Robert A. Hanson had.

The most memorable events were the compressor stalls and the "40 seconds or 40 dollars" maneuvers. I learned it from one of the Crane brothers, who had been in combat in Korea and had, as I recall, been on one of the early aerobatic teams. We did the maneuver in combat trail formation to elude our attackers. I flew 500 to 600 feet in back of the lead and stayed in a cone about 30 degrees to one side or the other, depending on the turns. When the lead called "Pull!" we

# Explore A History Of Flight With Identity Checks



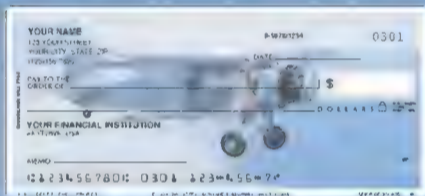
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**Blue Angels #9K30** (4 designs)  
Labels #9KB30  
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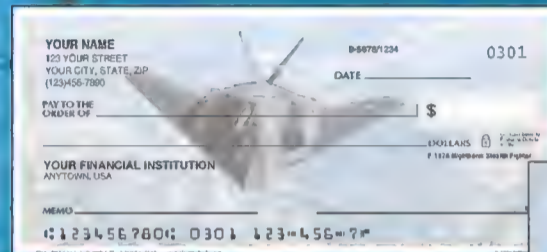


**Warbirds #9K02** (8 designs)  
Labels #9KB02  
Leather Cover #L9K02

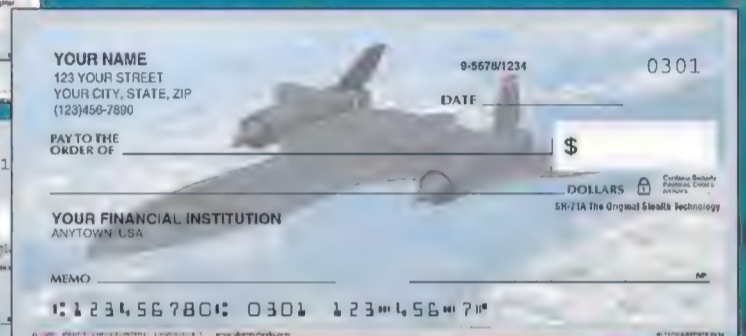
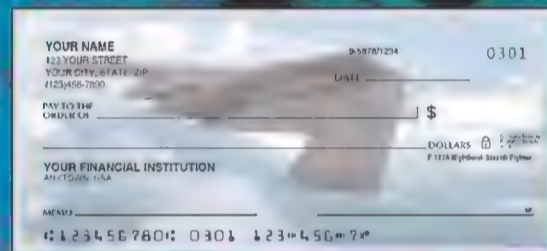
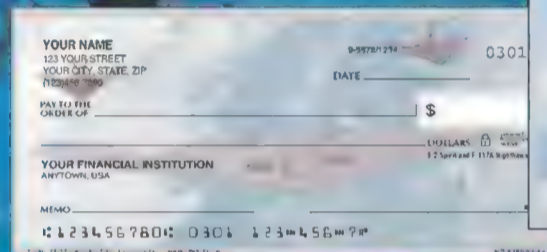


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MONTH

JAN

YEAR

54

DAY	AIRCRAFT		CHAR. ACTER OF FLIGHT	FLIGHT TIME AS				TOTAL FLIGHT TIME
	MODEL	BUREAU NO.		PILOT	CO-PILOT	STU-DENT	PAS-SANGER	
				AC	FP	CP	DP	SC
4	F4U-5N	124468	1A	2.0	2.0			
5	F4U-5N	124541	1A	.7	.7			
5	F4U-5N	124468	1A	.7	.7			
5	F4U-5N	124468	3A	1.0	1.0			
5	F4U-5N	124468	3A	.5	.5			
6	F4U-5N	124468	3A	.6	.6			
7	F4U-5N	124468	3A	.7	.7			
8	"	124468	3A	.5	.5			
9	"	124468	3A	.7	.7			
→ 11	"	124560	1A	.5	.5			
11	"	124698	1A	1.0	1.0			
14	"	124468	1A	.6	.6			
14	"	"	1A	.3	.3			
20	"	122206	3A	2.5	2.5			
21	"	"	1A	3.0	3.0			
22	"	122180	4A	1.8	1.8			
17	"	124468	1A	.5	.5			
25	"	124468	4A	2.0	2.0			
26	"	"	4A	1.5	1.5			

21.1

TOTAL-THIS PAGE

21.1

656.4

BROUGHT FWD.

20.0 331.5 14.8 101.4

677.5

GRAND TOTAL

20.0 553.6 14.8 101.4

VC.3

SPECIAL PILOT TIME					NUMBER CARRIER LDGS.	REMARKS
INSTRUMENT	MULTI-ENGINE	SINGLE-ENGINE	DAY	NIGHT		

"I knew her when..." Reader William Kershner's Navy logbook shows his familiarity with Corsair no. 124560, pictured in the Dec. 2002/Jan. 2003 issue.

both came full back on the stick and full rudder into the turn. The stick stayed dead center or all hell broke loose and so did the airplane. The whole airplane became a speed brake, and the stabilator, which was a nearly solid piece of metal, was curled up about a foot at each end. To get behind your adversary, you had to push forward on the stick at just the right time and shove the opposite rudder to the floor. It always worked!

The compressor stalls came when we did vertical scissors crossing back and forth across each other's flight paths, straight up, trying to get behind the other guy. At some point, you ran out of airspeed and maybe even started to slide backwards. *Bang! Bang! Bang!*—three bangs in quick succession knocked your feet off the pedals and increased your heart rate to the max. Captain Crane just calmly told me to idle the engine, take my hands off the controls, and wait. Sure enough, the nose came down and we started to fly again. Later, during the debrief, he said that the fire came out of both ends of the jet in a 30-foot torch. I'm glad I hadn't been able to see it.

One thing that always thrilled me—and I later flew all the models of the "Hun"—was the jolt of the afterburner on takeoff. You sit there holding the brakes at military power and the F-100 just jumps around as though it was eager to fly. Release the brakes, feel the pause as

the burner eyelids open, and then the jolt when the burner lights. I always said to myself, "Man, I'm gettin' paid to do this!" In my 20-plus years of flying the Hun, I had only one really serious incident, but that is another story.

Col. Joseph L. Vogel  
U.S. Air Force (ret.)

Lecturer, Aviation, Ohio State University  
Columbus, Ohio

## Corsair Memoirs

The F-4U-5N in the photo on page 42 ("CorsairFest," Dec. 2002/Jan. 2003) with "NP" on its vertical tail is Bureau no. 124560, an airplane I flew from the USS *Boxer* on January 11, 1954. According to my official Navy logbook (above), I made five carrier (day) landings on *Boxer* that day in 124560, plus six landings in no. 124698.

In 1954 we were preparing for deployment on the USS *Philippine Sea* as its night fighter team and spent a little over eight months in the Pacific doing day "snooper" flights as well. The Corsair was a great airplane, but with that large nose, you didn't get long in the groove, particularly during night approaches; seeing the landing signal officer and his paddles could get difficult.

William K. Kershner  
Sewanee, Tennessee

In 1946 I tried for an altitude record in a Piper Cub at the Beverly, Massachusetts airport. After an hour and 45 minutes at full (65 horsepower) throttle, I had mushed to an (indicated) 13,200 feet above Salem. Two Corsairs roared by, headed northeast up the coast. They were close enough that I could see the pilot of the near ship snap his head toward me as if to say, "What the...?"

After 20 minutes of spiraling down, I checked the specs and found that the published ceiling for the Cub was 11,500 feet. I have wondered about two things these past 57 years: (1) Did I really reached 13,200 feet? (2) What did his buddies think when the Corsair pilot told them about the little yellow plane at that altitude?

Theodore C. Fowler  
Trotwood, Ohio

*Editors' reply:* We can help with the first question. Altitude performance depends on air density, so the answer to your question depends in part on the air's pressure and temperature at the time of the flight. Then there's the kind of ceiling you reached: Our research shows that 11,500 feet is the J-3's "service ceiling," the height at which an airplane can still maintain some reasonably useful rate of climb—typically 100 feet per minute—in order to meet operational needs. So it is entirely possible for a Cub to reach an absolute altitude of 13,200 feet, as measured by an onboard altimeter.

You may also have gotten a ride in some convection—rising air—the way sailplanes do.

## Copcatski

The achievements of the Soviet aerospace industry during the cold war were often impressive, particularly its ability to automate vehicle control to an extent beyond that which American contractors might attempt, or which the U.S. military might find desirable. However, given both the obvious and the subtle similarities between Buran and the U.S. shuttle ("White Elephant," Dec. 2002/Jan. 2003), which include placement of maneuvering thrusters, rudder/speed brake configuration, and even the size and shape of the crew door, it is folly to attempt to call the near-identical Soviet spaceplane anything but a copy of its older U.S. counterpart.

According to author Tom Harpole, the Russian designers believe that "any group of aeronautical engineers will

COURTESY WILLIAM K. KERSHNER

# A floor lamp that spreads sunshine all over a room

The VERILUX® HappyEyes® Floor Lamp brings many of the benefits of natural daylight indoors for glare-free lighting that's perfect for a variety of indoor activities.

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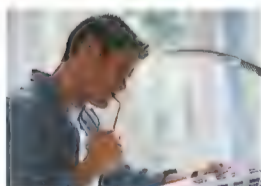
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...and when you need a good source of light for close-up tasks.

The VERILUX® HappyEyes® Floor Lamp will change the way you see and feel about your living or work spaces. Studies show that sunshine can lift your mood and your energy levels, but as we all know the sun, unfortunately, does not always shine. So to bring the benefits of natural daylight indoors, VERILUX, The Healthy Lighting Company™, created the VERILUX HappyEyes Floor Lamp that simulates the balanced spectrum of daylight. You will see with more comfort and ease as this lamp provides sharp visibility for close tasks and reduces eyestrain. Its 27-watt compact fluorescent bulb is the equivalent



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**You don't need the Sun to get many of the natural benefits of daylight**

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- See with comfort and ease
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- Uplifting, cheerful and bright
- Flexible gooseneck design
- Instant-on, flicker-free light

**Technology revolutionizes the light bulb**



- 5,000 hours bulb life
- Energy efficient
- Shows true colors

lent to a 150-watt ordinary light bulb. This makes it perfect for activities such as reading, writing, sewing and needlepoint, and especially for aging eyes. For artists, the VERILUX HappyEyes Floor Lamp can bring a source of natural light into a studio, and show the true colors of a work. This lamp has a flexible gooseneck design for maximum efficiency, and an "Instant On" switch that is flicker-free. The high fidelity electronics, ergonomically correct design, and bulb that lasts five times longer than an ordinary bulb make this product a must-see.



The VERILUX® HappyEyes® Floor Lamp will change the way you see and feel about your living or work spaces.

**This light can change the way you live and work**

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—Karen R. CA

*It really brightens up my office, Thank you.*

—Jan L. GA

*I use my computer all the time and WOW what a difference. I just put it up and I can see!*

—Kathy N. CA

*It is really nice and eliminates the glare!*

—Nita P. CA

*It is a nice sunny product for a windowless office.*

—Edith L. NJ

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arrive at similar designs for aircraft with similar purposes." To rebut that, one need only skip ahead in the same issue to "Winner Take All," documenting the Joint Strike Fighter competition. That story shows that two groups, given not just similar but identical requirements, can come up with two radically different approaches if they are truly isolated from each other. All it takes is one seemingly small decision during early studies to lead one designer along a path completely different from another's. If, however, a designer has a proven example in hand, he or she will inevitably gravitate toward the known entity, especially if working within the ever-present constraints of time and money. It's simply quicker and cheaper to duplicate a design known to work.

Tim Cacanindin  
Lancaster, California

While vacationing from my job as astronaut crew changeout technician, I was surprised to see what looked like an orbiter nose peeking out from under a tarp—in the Sydney, Australia harbor! Jumping from the tour boat and reaching the exhibit, I found it to be the atmospheric test vehicle for the Buran, with engines mounted. Since the Buran is a close copy of the Rockwell design, it probably leaks as badly as the originals—hence the tarp.

R. G. Van Treuren  
via e-mail

### The Mysteriously Missing Moonshots

I've been waiting for something on that Apollo moon camera for 30 years ("Shooting the Moon," Apr./May 2002). A few months after Apollo 11, I attended a talk at Harvard University's physics department by Edward Purcell about the camera and the photographs. Purcell attempted to project the photos in stereo, using polarizing filters, but that barely worked. He left a set of 35-mm stereo slides and a ViewMaster viewer in his outer office with his secretary to amuse visitors. Viewed using that medium, the photos are absolutely stunning. I recall one shot of pyrite crystals: The corners and edges that were out in the open had been fused, but the edges that were protected within the crevasses were still knife-sharp. It was a thrill to have my nose eight inches from the moon and stare at something that's been undisturbed from a time when there were "flashes" in the solar system that could melt the exposed surfaces of

minerals as well as much of life on Earth. It's the coolest thing ever to come out of the space program.

Since then, about every five years I've approached various parts of NASA (and several lunar scientists outside NASA) to try to buy sets of the stereo pairs. No one I've approached ever admitted hearing about a "closeup stereo camera," much less who has custody of the photographs it produced.

Robert J. Fowler  
Houston, Texas

### Hidden Figures of High Society

At the time George J. Marrett was selected to attend the U.S. Air Force Test Pilot School at Edwards Air Force Base ("Sky High," Oct./Nov. 2002), I was the program manager for the Dyna-Soar booster rockets at the Aerojet-General Sacramento, California facility. Our project group attended a full-scale-



*A gathering of Dyna-Soars (all pilots were with the U.S. Air Force except Neil Armstrong, who was with NASA). Left to right: William Smith, Aerojet; Earnest Steinman, Aerojet; Larry Post, Aerojet; Charles Mraz, Aerojet assistant program manager; William Knight, pilot; James Wood, pilot; Henry Gordon, pilot; Albert Crews (tentative identification), pilot; William G. Cowdin, Aerojet program manager; and Neil Armstrong.*

mockup meeting of all contractors at Boeing, in Seattle. While there, our group and the Dyna-Soar pilots were photographed in front of the booster (above). The pilot on the far right, with his eyes closed, is Neil Armstrong, the first human to set foot on the moon. I remember a conversation I had with Neil. At that time there was debate as to whether a pilot could react fast enough to prevent a catastrophic event, or whether automatic sensors should be included in the design. Neil's response to

me was "Give me a stick and throttle and I will fly the SOB."

William G. Cowdin  
Burbank, California

I was privileged to be on the design team with Kelly Johnson and Ben Rich from 1951 to 1956. The F-104's original duct inlet shock generator was a platypus type, which was not too efficient. My responsibility was to create the wind tunnel models to investigate the conical shock generator and develop the lofting criteria for manufacture.

Our development work was at top-secret level, so we were surprised to receive a page from a Japanese newspaper in 1954 showing their concept of the new fighter. It looked much too correct. I doubt the leak was ever found.

Max L. Lofland  
Half Moon Bay, California

"Sky High" did not mention the man who was the driving and coordinating force for the NF-104 rocket-powered trainer aircraft. When Chuck Yeager called Lockheed asking for assistance with the project, I was assigned to respond. As manager of Air Force aircraft sales, I flew out to Edwards Air Force Base and met with Colonel Yeager, who outlined what he had in mind to convert three F-104A fighters for astronaut training. He said he would ask one of his instructors to be his project manager.

Major Frank Borman received the assignment and worked directly with our people in developing the necessary engineering data for the NF-104. When the time came to obtain the obligatory contractual technical and funding authorizations from other Air Force headquarters, Major Borman invited me to join him.

At Wright Field, we met with a room full of technical specialist civilians who were expected to lay down some burdensome "mil specs" (military specifications) that were really not necessary for this small modification project. Well, Major Borman responded with a most forceful presentation that precluded any question of how the job would be accomplished.

Our next stop was the Pentagon, where higher Air Force officers had to be convinced of the importance of funding the project. Again, the professionally eloquent major made his case and thus ensured the success of the project.

David H. Kenyon  
Eugene, Oregon

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reports that it "can be a terrific antidote for delayed flights, engine noise, crackly airline headphones, and all the other nuisances passengers encounter."

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systems. As *Men's Journal* reports, it "puts the wearer in a zone of blessed quiet, then fills the ears with rich stereo sound." The *Boston Globe* calls the audio quality "superb." Travel expert Rudy Maxa finds it "stunning." Just what you expect from the most respected name in sound.

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## Make That Nine Most Wanted

I am a Royal Australian Air Force pilot. In October, I was flying in a formation to the remote central Australian town of Cenduna when, on landing, no. 2 in the formation blew both main-gear tires. We were stuck in Cenduna for four days awaiting a rescue. To pass the time, I wandered into the only newsstand in town, and lo and behold, there was your Aug./Sept. 2002 issue.

The Moments & Milestones section gave the National Aeronautic Association's "Ten Most Wanted" flying records. When I saw number three, the speed over a 15- to 25-kilometer straight course for a turboprop weighing less than 6,613 pounds, I veritably salivated. I went off, wrote to the Fédération Aéronautique Internationale, was put on to the FAI bloke in Australia, and registered to break the record.

This morning at 7:20, I set a new straight-course speed record in a PC9/A turboprop: 327.56 mph.

Flt. Lieut. Grant Fichera  
Royal Australian Air Force  
Pearce Air Base, Western Australia

## Fear of Ejection

"Ejection Seats" (How Things Work, June/July 2002) reminded me of an interview that baseball great Ted Williams gave to *Sports Illustrated* in 1955. Williams, having served as a Marine pilot in the Korean War, revealed that in aviation he feared two things. He had not been well trained in instrument flying, so he worried about running into instrument weather. Then the six-foot four-inch Williams told his interviewer, "My other fear was that the damn plane would blow and I'd have to bail out, because I knew I'd leave my kneecaps in the cockpit—I was cramped in so tight. I'd have to bail out with a can opener."

Mark Freitag  
Greenville, South Carolina

## Lonely Katie

The illustration of a Royal Air Force PBY Catalina on Diego Garcia island ("Seafarers," Dec. 2002/Jan. 2003) reminded me that today, a PBY lies on the island's east side (above right). I was stationed on Diego in 1998, and I learned that the PBY had belonged to the RAF's 240 Squadron. Because that unit's call letter was "K," the pilot, Officer James Parks, called the PBY "Katie."

According to Jim, in September 1944, Katie—registration number VA718—and crew flew more than 10 hours from Kelai in the Maldives islands through severe storms. As the craft pulled up to the mooring buoy at Diego, the engines cut out.

That night a storm hit the island, with winds up to cyclone strength, and Katie was torn from her mooring. With completely empty fuel tanks, she was very light in the water and was promptly run aground. A palm tree, buffeted by the wind, took off the aileron and rear portion of the wing, rendering Katie unflyable. And she has rested on her beautiful stretch of beach ever since.

MSgt. Jeffrey A. Nash  
U.S. Air Force (ret.)  
Elbert, Colorado

## After the Crash

"All That Remains" (Oct./Nov. 2002) contains the statement "Most everyone who has visited a fair share of [aircraft crash] sites has come across human remains." What was our military thinking, leaving aviators' bodies to vultures and vermin?

Edward Reif  
Moehrendorf, Germany

In response to Doug Parker's letter (Dec. 2002/Jan. 2003) regarding "All That Remains": I was the navigator of the B-52 that crashed at the Maine site he describes. Seven died, not six, and no parachute malfunctioned. The aircraft commander's chute worked, and because I never left the ejection seat, mine never deployed.

Gerald J. Adler  
Sacramento, California

## Everything but a Fighter

Evan Hadingham mentions the "last attempt at building one fighter" and then recounts the F-111's Navy and Air Force history ("Winner Take All," Dec. 2002/Jan. 2003). Despite the "F" designation, the F-111 was never intended to be a fighter for either service. The Air Force wanted, and eventually got, an outstanding tactical bomber (F-111A), while the Navy wanted, and eventually got—in the form of the F-14 Tomcat—an interceptor. The Navy's F-111B was never expected to perform as a fighter.

Elliott Stoffregen III  
Millbrook, Alabama



TED MORRIS

Meet Katie, a PBY that has been serenely decomposing on Diego Garcia for almost six decades.

## Plan B, Take 2

David Barlin's letter in the last issue, in response to "Shoot 'Em Up" (Oct./Nov. 2002), referred to the F-105 having a backup control system operated by cables. I flew the D, F, and G models and don't remember that. We did have a separate emergency system operated by hydraulics. It was pressurized by a ram air turbine that dropped down from, I think, the right front side, ahead of the cockpit. It powered only the horizontal stabilizer, via stainless steel lines that ran down the spine of the fuselage, well away from the other lines.

Chuck Banks  
Herndon, Virginia

## Corrections

Dec. 2002/Jan. 2003 "Chalk's Ocean Airways": The Albatross did not serve in World War II; the prototype first flew in 1947. We regret the error, which we introduced during editing.

"Fairey Tale" (Soundings): Eddie Kurdziel has configured his Fairey Firefly to represent one operated by the Royal Australian Navy, not the British Royal Navy.

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# It's a Dog's Life

**A**s sled dogs have learned, the view never changes unless you're the lead dog. In the airshow industry, the performer is the lead dog, and a whole team of grunts do most of the pulling. Grunts, who are sometimes husbands or wives, sweat the details, serving as fetchers, fixers, smoke oilers, and washers and waxers.

Each December at the International Council of Air Shows convention, new grunts compare views. At the ICAS meeting of United Airshow Grunts, grunts never let the word "performer" pass without a resounding jeer. Encroaching performers (*boooo!*) are chased off with Silly String or fizzed with a shaken beer.

At a 1992 airshow in Roswell, Georgia, "Big B" Beardsley, the barrel-chested towman and wrench behind Bill "Burner"—the performer (*boooo!*) who flies the Bud Light Micro Jet (and, coincidentally, shares Big B's last name)—was grumbling in the hot sun, along with fellow grunt Brian Norris. Norris is ferry pilot, pole-holder, and water-bottle-getter for aerobatic superstar Sean D. Tucker. Beardsley and Norris banded together and launched the U.A.G. Then came the ritual of dog names.

They say Tucker was chatting with Patty Wagstaff on a break at Warrenton, Virginia, a favorite practice site for aerobats. Tucker's grunt, Norris, and Wagstaff's grunt, Clyde Green, stood nearby. "You know, Sean," said Wagstaff, nodding at Green, "I wish my dogs worked as hard as yours."

Ever since, more than 250 grunts have taken canine names, becoming part of the Registered U.A.G. Kennel. Most adapt their names from the more polite terms coined by their masters: Whizzer, Cinder, Smoky, Hey You, Cargo, Do It, and Hey Red. At the 2002 meeting, Thomas Farrankop assumed the dog name Chucker. Farrankop grunts for Rich Gibson of Rich's Incredible Pyro, lighting the fire under simulated bomb and strafe runs.

Norris (Dingo) is U.A.G. Corporal at Arms. Current U.A.G. president is Donna Shockley, who is married to Les, the



DAVID CLARK

performer (*boooo!*) who drives the 300-mph Shockwave Jet Truck. Vice president Lyn Mohr is married to John Mohr, a Stearman pilot who has won the Art Scholl Showmanship Award, one of the airshow industry's most prestigious. And despite U.A.G. dues of \$2, treasurer Patti Chapman has never had more than 40 cents in the coffers. (Chapman's husband Matt has led the U.S. Aerobatic Team.)

"United Air Show Grunts is for anybody who works to make that performer as great as he is, behind the scenes," says Donna Shockley. "By definition, you cannot receive applause, you can't sign autographs. You keep things clean, you do set-up, whatever it takes."

Patti Chapman (Keeper) says that during the 1998 International Aerobatic Club finals in Slovakia, she had to stomp her performer's flightsuit clean in the bathtub. New U.A.G. member Guido, who wished to remain anonymous, won 2002's Air Show Rental Car Extreme Use award, logging 2,009 miles in three days, which also won him Closest Match to Current Year.

"Grunts are the lowest element of the food chain," says Lyn Mohr. "We have fun poking the performers, but it's a Catch-22. We wouldn't be anywhere without each other."

—Roger A. Mola

## The Plus Side of Aeroelasticity

**W**hen the Wrights needed a way to bank the *Flyer* to make a turn, they invented wing warping, a system of cables and pulleys that would twist the airplane's wings in opposite directions to provide control in the roll axis. Soon ailerons proved more efficient. Now, a hundred years later, wing warping is back. NASA, the U.S. Air Force, and Boeing's Phantom Works have fitted warpable wings on an F/A-18 to explore the technique for roll control at transonic and supersonic speeds. Unlike the Wrights' system, the Active Aeroelastic Wing, or AAW, uses no cables: It induces twist by aerodynamic forces. Actuators deflect its split leading-edge flaps a few degrees, and the deflection exerts aerodynamic loads that, along with the loads produced by the

## A Module of One's Own

Sure to turn up in the next Hammacher Schlemmer catalog is a museum-quality replica of the International Space Station Destiny Module, now offered for sale to the general public. Constructed by Johnson Engineering in Houston, a sister company of the shuttle add-on module maker Spacehab, the 20,000-pound replica has an observation window with flat-panel-screen Earth views, plus an astronaut cabin with a Russian sleeping bag, treadmill, and payload racks with flight decals and labels covered by a glass floor. The racks include a Microgravity Specimen Glove Box, World Observation Research Facility, Treadmill Vibration Isolation System, Human Research Facility, Zero-G Stowage, and Temporary Sleep Station with accommodations for one. A five-channel home theater sound system supports audio effects and, with looping video, "convey[s] the feeling of a working module on orbit."

Available from [www.thespacestore.com](http://www.thespacestore.com) for \$2,500,000. "Allow six months for creation and delivery," Space Store advises.



aileron, warp the outer wing panels—in effect, the outboard leading edge flap is used as a control surface. If the method can be perfected, ailerons could eventually become obsolete—wings could be made up to 20 percent lighter and aerodynamically more efficient.

The modified wing is a design that was rejected on early F/A-18 models as too flexible. Aileron inputs at high speeds were twisting the wing, countering the input. "Roll rates would be reduced by 80 percent going transonic," says AAW project test pilot Dick Ewers. Dave Voracek, NASA's AAW engineer, says the team had to replace only about 30 percent of the old wings' surface with composite-and-aluminum panels. Still, this is brand-new territory: To determine forces like flutter, the instrument-laden wings

*Can this F/A-18 prove that we should have stuck with wing warping all along?*

measure 1,800 parameters over about 50 flights.

Ewers says wing flexing is more efficient than ailerons. "If you deflect a leading edge device just one degree, it's an order of magnitude difference in terms of deflection compared to an aileron," he says. "The advantage is transonic and supersonic—you don't need much twist at those speeds to induce roll. It leads me to believe you could make a much more maneuverable airplane than today." Ewers emphasizes that the object of the AAW project isn't to increase the roll rate of the F/A-18. "The F-18 already has more roll rate than a pilot can handle," he says. "The problem is in making it uniform over a wider speed range using the flex wing alone." It will be an accomplishment—the production F/A-18, like most modern combat airplanes, uses differential stabilators to achieve high roll rates.

Wing twist may have advantages at slower speeds too. "After all, the Wright brothers used it at 40 knots," says Voracek. "What it may eventually mean is an aircraft that can transform or morph into an optimum shape for whatever speed regime it's flying in."

—Graham Chandler

## Taming the Wild Asteroid

Shoot it with moon-based lasers. Repel it with solar energy focused through parabolic mirrors. Move it with giant reflective balloons. These are just a few of the ways scientists envision diverting a doomsday asteroid as they debate socially acceptable alternatives to blasting it with nuclear warheads. From the University of Arizona comes another novel proposal: Paint it.

According to Joseph Spitale, who put forth the idea last spring in the journal *Science*, it should be possible to change the path of an asteroid on a collision

course with Earth by changing its surface temperatures. "If you could cover the surface with a millimeter of white material," says Spitale, "that could produce a fairly big change in where the body would be in another century or so."

Spitale's scheme takes advantage of an obscure phenomenon first described a century ago by a Polish engineer, I.O. Yarkovsky, who pointed out that unevenness in heating will cause a body moving in space to drift. The sunlit side of a space rock gets much hotter than the shady side (for instance, temperatures on Eros, the space rock now home to NASA's Near Earth Asteroid Rendezvous probe, range from 212 to -238 degrees Fahrenheit). The warmer side gives off more thermal radiation, and the difference creates a slight difference in momentum that infinitesimally alters an orbit, though the effect is "really, really weak," Spitale says.

On March 16, 2880, an asteroid designated 1950DA will cross paths with Earth, and the occasion offers an opportunity—and plenty of time—to test Spitale's theory. "It is a very good candidate," he says. Scientists put the odds of a collision at 1 in 300—unless 1950DA is painted.

Transporting the paint—or powder, or even powdered sugar, some 4,000 cubic yards of it—poses less of a problem than distributing it properly. "All you need to do is make sure that there is an adequate depth everywhere on the surface," says Spitale. "However, if it's not uniform, then you're wasting material. If you have less in a given spot, then you'll get a temperature anomaly." The simplest way to cover the asteroid may be to arrange a controlled crash that would distribute the material across a patch of the surface, but many spacecraft would be required.

—Beth Dickey



NASA DRYDEN FLIGHT RESEARCH CENTER

## Music of the Spheres, Part II

One thing you have to give Bert Ulrich: His taste is eclectic. The curator of NASA's art program—which for 40 years has paid small honoraria to painters, poets, and occasionally composers to interpret the agency's activities—recently commissioned two pieces of music that couldn't be more different if they'd been written on separate planets. One is a heart-tugging, sometimes soaring pop recording by Patti LaBelle, called "Way Up There." The other is an hour-long, 10-movement musical composition that mimics the natural sounds of space, performed by experimental music pioneers the Kronos Quartet. A little something for everyone in this centennial of flight.

It was in fact the centennial that prompted the creation of "Way Up There." Ulrich got to talking to Warren Betts, a Los Angeles publicist and veteran of space-related projects like Clint Eastwood's *Space Cowboys*, who

happened to have a client interested in penning NASA's musical contribution to the centennial-of-powered-flight celebration: Tena Clark, who started as a drummer, went on to write jingles for McDonald's and songs for movies, and now is a music packager for Disc Marketing, her own L.A. company. Among her gigs is putting together the playlist for President Bush and his staff to listen to on board Air Force One.

After Ulrich contacted her, Clark wrote "Way Up There"—appropriately, at 30,000 feet during a commercial flight. A pop hymn to the romance of airplanes and spaceflight, it includes the lines "Imagination and amazing grace bring us closer to our home in space." LaBelle, who had worked with Clark and recorded the song, is a space aficionado herself, having been NASA's VIP guest at a shuttle launch. LaBelle's rendition is somewhere between "Slipping the surly bonds" and "New

Attitude," with a gospel choir in the background for the swelling parts.

The Kronos piece is more cerebral, and more purely Ulrich's idea. He sent a tape of sounds—eerie hums, hisses, and chirps collected by spacecraft as they passed through Jupiter's magnetic field and other electrically charged realms—to the quartet, hoping they'd be inspired to produce music for the art program. Kronos violinist David Harrington asked avant-garde composer Terry Riley to write a piece, and the result, "Sun Rings," debuted last October at the University of Iowa, home of space physicist Don Gurnett, supplier of the space sounds.

Don't look for "Sun Rings" on MTV, but Kronos will perform it in London and other cities over the coming year. LaBelle's single was released on CD on December 17, timed for the kickoff of the centennial, which now, thanks to Bert Ulrich, has a soundtrack.

—Tony Reichhardt

## IN A MODEL WORLD

### The Best-Saved Plans

When earlier this year, the Academy of Model Aeronautics acquired the late John Pond's collection of over 13,000 model aircraft plans, 1,600 engine drawings, plus wing rib and parts templates from old kits, it garnered much more than a wealth of documentation for its archives. The addition more than triples the existing AMA plans collection. Further, it reunites the full-scale plans with the design articles for each from the AMA's comprehensive library of "just about every issue of every model airplane magazine ever published," according to National Model Aviation Museum curator Michael Smith.

The oldest and rarest of Pond's plans hark back to the 1930s, the heyday of the stick-and-tissue, rubber-band-powered free-flight model, a decidedly charming technology whose popularity declined after the advent of the gas engine, the U-Control mechanism for tethered flight, and radio control. The plan collection includes designs that were printed in newspapers. Many were duly constructed and entered in citywide contests held in public parks. Budding aviators built models from plans available from sources like the "Air Adventures



of Jimmy Allen" radio show, a contemporary of radio hero Captain Midnight. Over the

years, Pond had accumulated in many cases the only known originals of many such plans.

Surprisingly, some of the oldest of those have the most potential in modeling's future. The

delicate balsa stick structure, originally intended to be covered by tissue and powered by a rubber band, turns out to be an ideal airframe for the latest in light Polyspan coverings, geared electric power plants, and microscopic radio control systems.

The academy intends to digitize the plans and, once copyright issues are resolved, make them

## NASA's No-Fly Zone

Call them the Management 37. Unlike the Original Seven of Project Mercury, or even the TFNG—thirty-five new guys—of the shuttle era, these U.S. astronauts do not fly spacecraft. Most fly desks.

Because federal budget writers and the press are paying close attention to the size and cost of training its corps, NASA created a category for career astronauts who are not eligible for flight assignments because they are on sabbaticals or administrative leave or are serving the space agency in other capacities. Management status is considered “career development” for veteran shuttle commanders and other key mission leaders, and as of last August, 37 of NASA’s 147 astronauts were enjoying it.

But one astronaut’s delight may be another’s displeasure. Some of the niftier trappings of astronaut life are off limits to most management astronauts. Managers are not required to maintain proficiency in T-38 jet trainers, mission simulators, and the big swimming pools where spacewalks are rehearsed. The truth is, they aren’t

*A generation of model builders cut their teeth on model aircraft plans in magazines and newspapers. These plans eventually formed the nucleus of John Pond’s voluminous collection, which was recently acquired by the Academy of Model Aeronautics and will soon be made available to new generations.*



MICHAEL SMITH, CURATOR, NATIONAL MODEL AVIATION MUSEUM

available as files that can be transmitted over the Internet. Widespread availability may further a revival of quiet, graceful scale flight at the hands of park fliers as the stick-and-tissue genre comes full circle.

—Larry Lowe

## ARTIFACTS

### “Turn It Down!”

In 1942, the Chrysler-Bell Victory Siren represented a big step beyond air raid sirens driven by electric motors. With a gas V-8 to operate the noisemaking device, its self-containment was one advantage. As for the volume—a total of 170 decibels from its six exponential-type horns—it produced sound “so intense that it would probably render anyone foolish enough to step in front... permanently deaf,” according to a Chrysler engineer of the day.

New York tested the Chrysler-Bell Victory Siren on July 4, 1942; from its revolving perch on the RCA Building, it overpowered the nearest of 407 electric sirens distributed citywide, making them sound like popcorn whistles, the *Herald-Tribune* reported. Nine additional sirens were ordered (list price per unit: \$3,760). Detroit and Chicago installed 20



RONALD AHRENS

*Play “Taps” for this powerful Trenton, Michigan air raid siren.*

each. Even after the war, sirens were purchased for air raid and tornado warnings.

In the 1950s, Chrysler put its powerful Hemi V-8 engine in the sirens. The unit seen here served in Trenton, Michigan, from 1958 to the 1970s, causing people to complain about the regular tests. On December 9, 2002, it came down for restoration and eventual display at the Walter P. Chrysler Museum in Auburn Hills.

—Ronald Ahrens

allowed to keep current. “They don’t use the facilities except for very specific occasional events,” says Charlie Precourt, a four-time flier on management status. Until recently the boss of the astronaut office, he was required to fly T-38s and the Gulfstream II Shuttle Training Aircraft.

NASA spends roughly \$61.5 million in fixed costs a year—including about \$25.4 million for aircraft—on astronaut training facilities. Certifying a commander and a pilot for a specific shuttle mission costs about \$2 million a year; a complete seven-member crew, about \$4.5 million. NASA developed these estimates for Sean O’Keefe in November 2001, just a month before the White House budget officer was confirmed as the space agency’s new administrator. At the time, only 14 members of the corps were in management positions, and 111 still were considered “assignable.”

The new structure shows a military-style career progression. Astronauts arrive at NASA as mere candidates. After a two-year training period, they graduate to active “career” status. They work technical jobs, for example, to hone their

skills while waiting for a rookie flight assignment. The rest of the active corps consists of flight-qualified commanders, pilots, and mission specialists.

In Washington, D.C., bureaucratic wisdom dictates that career astronauts will vie for permanent management jobs after gaining leadership experience in space. But in Houston, where they live and train, management assignments are temporary, according to Precourt. “A lot like in the military, we move people around,” he says.

Restructuring the corps doesn’t save a lot of money. But NASA says it does solve one big problem: It helps Washington lawmakers, budget watchdogs, and the press comprehend the astronauts’ varied duties. “We wanted to make it clear we have a lot of astronauts throughout the agency fulfilling a lot of different roles,” says Precourt, “and that all of those here are not equally ready for flight assignments.” He hopes the change will also show that the same training infrastructure is necessary, whether NASA is training one astronaut or 200.

—Beth Dickey

# Tales of the Flood

**B**ack in Stanley and Livingstone's day, discovering the source of a river like the Nile entailed hacking your way through the jungle and fending off disease and a nasty assortment of bugs and beasts. Tracing waterways on Mars is more comfortable, since it can be done sitting at a computer with a cup of coffee. But in some ways it's trickier.

For one thing, the water's missing. Whatever rivers and lakes once existed—and we know they did from photos of dried Martian stream beds taken in the 1970s—have long ago disappeared. Still, scientists like Ross Irwin of the National Air and Space Museum's Center for Earth and Planetary Studies are not without theories. And using data from the Mars Orbiter Laser Altimeter (MOLA), which has been measuring surface elevations on the planet since 1998, he recently discovered what was once the largest highland lake—and is today a dried lakebed—ever found on the Red Planet.

Irwin was looking for the source of a large valley called Ma'Adim, the Hebrew word for Mars, which dead-ends in a circular basin called Gusev Crater. More than

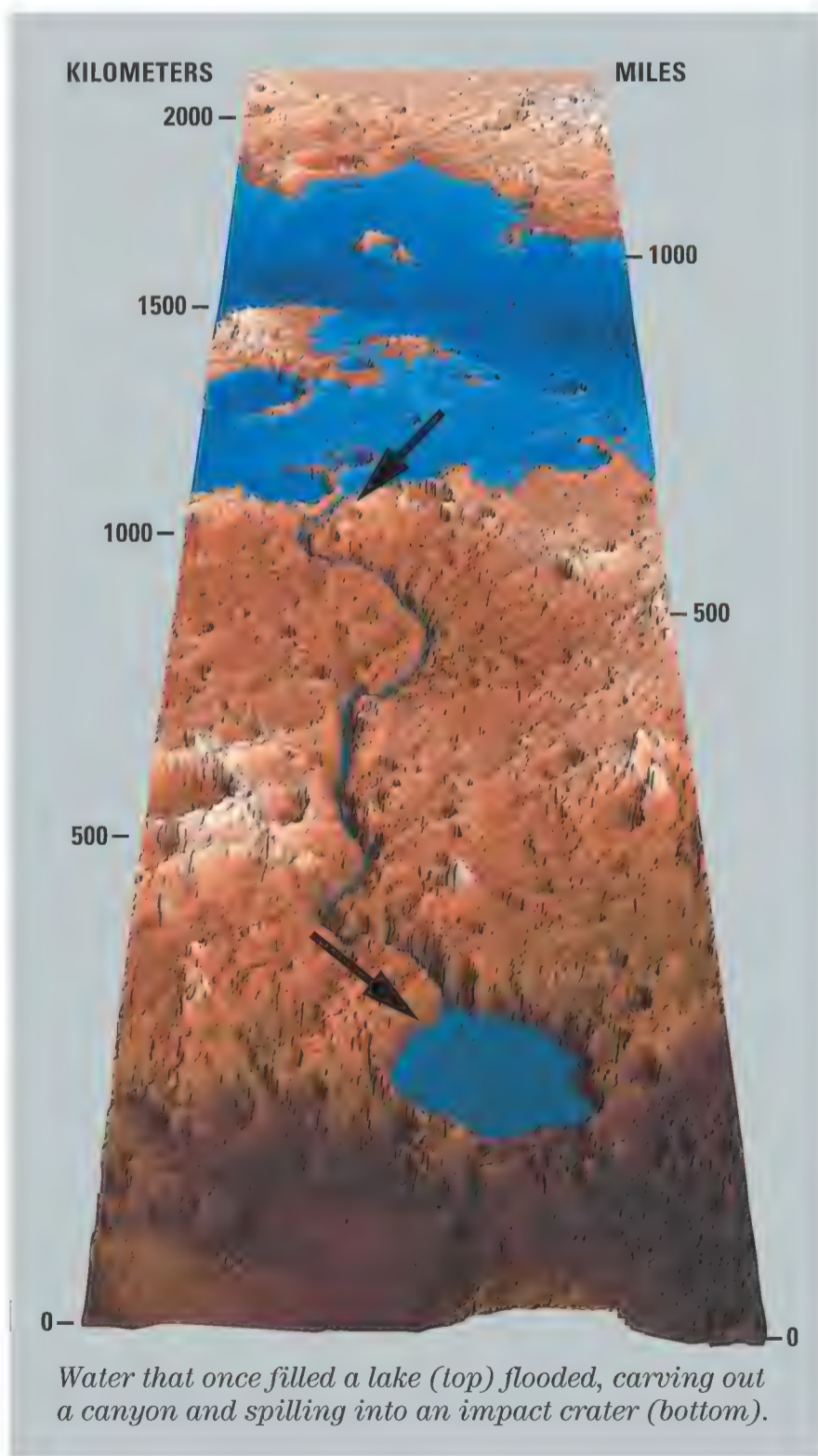
two miles wide and 560 miles long, Ma'Adim Valley is bigger than the Grand Canyon, and was likely also carved by running water. The question is what water. Irwin followed the course of the valley in spacecraft photographs until he noticed a place at the opposite end from

Gusev where it started to cross a ridge but didn't come out the other side. "There's only one way to get a large channel like that emerging at a ridge," he says, "and that's to have water pond up behind the ridge and overflow."

Having found his spillway—the source of the water that cut Ma'Adim Valley—he then used contour maps made from MOLA elevation data to reconstruct the perimeter of what was once a 1,400-mile-wide lake. Erosion channels feeding into the lake disappeared below that contour level, just as would be expected if the level used to be the water line. "Everything lined up very nicely," Irwin says. Scientists have suspected that other ancient lakes, and even oceans, existed in low areas on Mars where water naturally would settle, but nothing this big in the highlands, where any lake would have formed by precipitation.

Irwin can imagine the catastrophe that created Ma'Adim Valley happened some 3.5 billion years ago, when many scientists think Mars was warm and wet and had an atmosphere roughly as dense as Earth's today. In his scenario, the original lake overfilled its basin, perhaps during a period of heavy rain or snow, and broke through the spillway. A tremendous flood, with five times the amount of water contained in the Great Lakes, came rampaging out to carve the deep valley that is dry today. It happened quickly in geologic terms, but just how quickly? "From months to years" is what Irwin guesses, depending on how deeply it cut and how fast the water was rushing (only about 60 percent as fast as it would have had it been subjected to Earth's stronger gravity).

Satisfied with their detective work, Irwin and his CEPS colleagues published their results in *Science* magazine last June. But unlike the European explorers



## VISITOR INFORMATION

**Hours** The National Air and Space Museum is open 10 a.m. to 5:30 p.m. every day except December 25. General admission is free.

**Location** The Museum is located on the National Mall at 7th Street and Independence Avenue SW, Washington, D.C., just west of the U.S. Capitol. The closest Metrorail stations are L'Enfant Plaza and Smithsonian.

**Food** The Wright Place serves breakfast and lunch fare from McDonald's, Boston Market, and Donatos Pizzeria. Hours: 7:30 a.m. to 5 p.m., Monday through Friday, and weekends from 9 a.m. to 5 p.m.

**Lockheed Martin IMAX Theater** View Earth from the open cargo bay of the space shuttle. Journey to natural and man-made wonders of the world. These and other thrills await you at the Museum's IMAX theater, where large-format films are projected onto a screen seven stories wide and five stories high. For more information, call (202) 357-1886 or (202) 357-2700.

**Albert Einstein Planetarium** Embark on a celestial adventure. Realistic astronomical experiences are produced under the planetarium's 70-foot dome. For information, call (202) 357-1686.

**Tours** Free docent-led tours highlight the Museum's collection and trace the history of air and space travel. Tours are given daily and depart from the Tour Desk, South Lobby, gallery 108. For more information on tours, programs, and science demonstrations, call the Tours and Reservations Office at (202) 357-1400.

**Paul E. Garber Preservation, Restoration and Storage Facility** It's closing on March 31, 2003, so now is the time to get a behind-the-scenes look at the Museum's aircraft restoration workshop in Suitland, Maryland. For more information, call (202) 357-1400.

*Except where noted, no tickets or reservations are required. To find out more, visit [www.nasm.edu](http://www.nasm.edu) or call the Smithsonian Information line at (202) 357-2700; TTY (202) 357-1729.*



The Steven F. Udvar-Hazy Center features an IMAX theater (foreground), an airplane hangar, and the 164-foot Donald D. Engen Memorial Tower.

## The Countdown Begins

With the December 15 opening of the National Air and Space Museum's Steven F. Udvar-Hazy Center just 10 months away, work continues at the construction site near Washington-Dulles International Airport in northern Virginia. Anchored by a 10-story airplane hangar that could encompass three football fields, the Hazy center will house some 300 air and space artifacts, some of which have never been on public display. Surely one of the homeliest air-



The Bachem's mission was to attack Allied bombers with 24 nose-launched rockets.

craft to be displayed at the Hazy center is the Bachem Ba 349B-1 Natter, which Nazi Germany built to defend itself near the end of World War II. "Natter" is German for viper or adder; engineer Erich Bachem designed his craft to strike enemy airplanes with what he hoped would be snake-like quickness and precision. The Bachem wouldn't waste time rolling down a runway; instead, it would launch vertically in an attempt to shoot down the Allied bombers that were attacking German military targets during daylight raids. Powered by a liquid-fuel rocket engine and four strap-on solid-fuel rocket boosters, the Bachem would launch from a 79-foot tower, jettison the boosters, and climb 20,000 to 30,000 feet. The pilot would then steer the craft to within one to two miles of a bomber formation, launch 24 unguided, nose-mounted rockets, and escape the fuel-exhausted craft by parachute. Natters never had a chance to prove their effectiveness, as the war ended before any of them could strike.

who got to name geographic features for benefactors or loved ones, they won't have a hand in naming their newly discovered lake. The idea of water on Mars is too new, and too far from universal acceptance, for Irwin to worry

about such vanities, he says. Besides, planetary features tend to be named after historic scientists. "In order to name anything after oneself," says Irwin, "you pretty much have to be dead."

—Tony Reichhardt

# One Very Cold War

I was standing in the aisle of an Air Force C-47, leaning on the backs of the two pilots' seats and looking out the front windshield, when the pilot said, "There's the runway straight ahead." It took me a moment to realize I was looking at what we were going to attempt to land on. I saw a short, very narrow strip carved out of the side of a mountain, and at the approach end, there was a cliff that dropped off several hundred feet. To the left of the strip was another dropoff that appeared to plunge about a thousand feet. The mountain on the right side was too close to call; our wing was either going to hit it or, if the pilot was very good, miss it by inches. Everything was covered in snow, and snow was piled high at the far end of the so-called runway, so I knew we could not make a go-around. I returned to my seat, fastened my seat belt, and hoped the pilot had done this before.

Apparently he had. A few minutes later I felt a slight jolt as the wheels touched down. After a short roll, the aircraft stopped and turned 180 degrees. The pilot kept the engines running as I climbed out into the -30-degree air. In a few minutes he'd take off again, and over the next several days I would discover what life

aircraft. Stations further inland were designated Ground Control Intercept (GCI). They would most likely control the scrambled fighters in the event of an attack.

When I visited Cape Romanzof and other remote radar sites, I was an operations officer with the 10th Air Division, which was headquartered at Elmendorf Air Force Base, near Anchorage. I had flown fighters in World War II, but my job with the 10th was to assist the AC&W squadrons in developing efficient procedures to counter a Soviet attack. Between 1953 and 1955, I visited all the AC&W squadrons in southern Alaska, the 10th Air Division's area of responsibility. Most had been operating for just a few months when I arrived.

At Cape Romanzof, the base camp was in a valley between peaks of the Askinuk Mountains, about 1,000 feet above the landing strip. I spent most of my first day there in the dark radar control room watching the controllers track a few aircraft on their scopes. All radar operations rooms are basically the same. When you first enter, you're surrounded by darkness, and the only sound is the low hum of the radar consoles and the muted

on alert, ready to scramble. The controllers also told me that we were within the range of the MiG-15 and that a strafing attack on the radar base could not be ruled out.

These were times when both sides were on such high alert that a fight seemed almost inevitable. The Navy at Kodiak Island was flying patrols with P2V Neptunes over the Bering Sea, and the Air Force patrolled the coast with RB-29s, -47s, and -50s from Ladd and Eielson Air Force Bases. Between 1951 and 1956, Soviet fighters shot down eight of these aircraft, resulting in the death or disappearance of 64 crew members.

At all AC&W stations in Alaska, the buildings were attached so no one need go outside in winter unless absolutely necessary. When I first entered the hallways, they were full of people walking up and down as if they were strolling down Main Street in some small U.S. town. The men explained that after being inside for several months, sleeping became difficult. Rather than toss and turn, some men teamed with a buddy and walked the halls, talking about anything but where they were, or what might be happening back home or "outside," as they called the United States. (Alaska wasn't granted statehood until 1958.)

The tours at the radar camps were limited to one year because of the psychological strain and physical hardships. The only means of getting construction materials and supplies to Cape Romanzof was by barge or a Navy landing vessel designed to carry tanks and other equipment during amphibious assaults. But these could come only when the sea was not frozen.

The Army Transport Corps undertook the project, code name Mona Lisa, of getting the initial supplies to the station. They weighed 1,147 tons and had to be unloaded 15 miles from the proposed site. There were no roads. Every item had to be hauled along the beach to the area nearest the construction site, then an additional five miles inland to the permanent storage area.

**It took me a moment to realize I was looking at what we were going to attempt to land on. I saw a short, very narrow strip carved out of the side of a mountain, and at the approach end, there was a cliff that dropped off several hundred feet.**

was like at the remote radar stations on the Alaskan coast of the Bering Sea.

In the late 1940s and early 1950s, the United States worried about the Soviets attacking via air routes over the North Pole or across the Bering Sea, and began constructing radar stations for aircraft control and warning (AC&W) over the entire United States and along the Canadian border. Ten were eventually built in Alaska. The remote stations along the Bering Sea—Cape Romanzof, Sparrevohn, and Newenham—were designated Early Warning (EW) since they would be the first to detect an enemy

chatter of the controllers. As your eyes adjust, you begin to distinguish the operators hunched behind their scopes, a few hooded lamps, and the large plotting board for tracking aircraft.

Some of the aircraft on the radar screens were Soviet, and sometimes, the controllers told me, Soviet fighters would head directly toward them as if on an attack but would turn back just before reaching U.S. waters. Had the fighters kept coming, a message would have been radioed to Elmendorf, where one of three squadrons of Northrop F-89 Scorpions were based. One of the three was always

The inaccessibility made the radar crew at the sites responsible for maintenance if anything went wrong, at least until help could arrive. During a bout of severe weather at Cape Romanzof, a water main froze and ruptured. Water and sewage facilities for every area except the kitchen were shut down for three weeks. During that period, another source of water had to be found, and the men discovered that by repeatedly filling four 55-gallon steel drums with snow and applying steam, they could produce 7,000 gallons of water in a day. Both officers and crew took turns shoveling. Finally, some relief was found by breaking the ice on a nearby lake and pumping the water back to camp. The men at the remote stations became pretty adept at repairing almost anything.

Cape Romanzof and Newenham had a tramway connecting the base camp with the radar antenna located on top of the nearby mountain. The tramway cables were constantly breaking because of high winds and ice, and fog and the extreme cold made repair hazardous. At times 16 or more inches of ice built up on the cables. The tramway at Newenham had broken twice; once a car fell about 75 feet, injuring several men.

Building the radar installations was itself a heroic undertaking. One of the later sites to be constructed in Alaska was situated on Sparrevohn Mountain, a 3,200-foot peak 210 miles west of Anchorage. The Department of Defense hired civilian contractors for most of the construction projects, but the one on Sparrevohn Mountain was assigned to the Air Force's 813th Engineering Aviation Battalion. The site was not accessible by road, and there was no airstrip (that would come later). The construction crews were flown in by helicopter, lived in squad tents, carried water from a nearby stream, and used field latrines. Helicopters also brought them supplies. On one resupply mission, the helicopter pilot had to chase away four bears before he could land.

All the construction materials and machinery also had to be airlifted and dropped by parachute from helicopters or other cargo aircraft. At first, all the bundles were hauled to a staging area by teams. Finally, a Caterpillar D-4 tractor was dropped, piece by piece.

The drops weren't always precise. The tracks for the tractor had to be moved by hand about a mile from the drop point to an assembly area, where the workers attached them to the tractor frame, then towed the whole assembly to the camp. The tractor's engine was dropped about 500 yards from the assembly point, so the team erected a primitive hoist to lift the components into place. After the tractor was built, recovery of other items became considerably easier.

For better range, all the AC&W radar

antennas were placed on top of the mountain nearest to the base camp. At Sparrevohn the distance from the base camp to the antenna was more than a mile. With weather so severe in winter and the base camp so far away, the Air Force decided to build a blockhouse on top of the mountain near the antenna with minimal facilities for the men, assuming that sometimes the weather would force them to remain there for several days or longer. Also, the tramways at the other sites had been so much trouble, it was decided to build a road up the mountain instead. The road followed a series of switchbacks, a pattern of gradual inclines that zig-zagged across the face of the mountain, from the bottom to the top. It was surfaced with gravel and dirt, and there was no guard rail.

On one visit to Sparrevohn I finished my work at the mountaintop and, not wanting to call for transportation to come from the base camp, I hitched a ride with an airman in a light truck. The driver looked at his watch, put the gas pedal to the floor, and took off downhill. I grabbed hold of everything I could just to stay in the truck. As we rounded the first switchback, the front of the truck appeared to extend into thin air. I just held on as tight as I could. Finally, we reached the base camp. As I stepped out

of the truck, the driver began shouting "I did it, I did it, I did it!" I was about to ask him if he was so happy because we had survived the trip when he shouted, "I broke the record!" Apparently, the drivers had an ongoing contest to see who could make it down the mountain the fastest. I would not want to be on board if this driver's record was ever broken.

Sparrevohn was one of the most difficult sites to fly into, especially in winter. All supplies had to be flown in, usually by C-47s. The only approach was from the south, around a mountain to a runway with a 12-degree up-slope. As the pilot rounded one mountain, another was staring him in the face at the far end of the runway, which was only 1,500 feet long. Sometimes the mud got so deep during the thaw season that a C-47 would have to use full power after landing just to reach the top of the hill.

Even though the weather at Sparrevohn was bad most of the time, the USO, the military's favorite entertainment organization, managed to get in there and put on a show: "Gloom Chasers," a one-and-a-half-hour variety act with an all-girl band. The venue was an unheated mess hall, and the girls, according to a later review of the show, "wore evening gowns and goose-bumps."

—Paul R. Cochran



PAUL SALMON

# Figured Out

If the various teams scratch-building authentic Wright *Flyers* for powered flight's 100th anniversary (see "In Search of the Real Wright *Flyer*," Dec. 2002/Jan. 2003), a great many, I'm happy to report, have spent a good amount of energy finding equally authentic Wrights to play the part.

On December 17, for example, at precisely 10:35 a.m., a suitably authentic Orville, modeling proper period garb, will reenact the events of a century prior and guide The Wright Experience's *Flyer* into the air over Kitty Hawk. At about the same time, on the lawn of Chicago's Museum of Science and Industry, the Wright Redux Association's reproduction, helmed by a mustachioed Orville, will launch with equal verve and verisimilitude. Even former astronaut and U.S. Senator Jake Garn may don a cap and bow tie to pilot Utah State University's modified *Flyer* at the Inventing Flight celebration in Dayton, Ohio.

No word yet on the pseudo Wilburs who will run alongside.

Of course, not all facsimile Wrights have to be skilled with the hip cradle to serve effectively. During wind tunnel testing of the American Institute of Aeronautics and Astronautics' *Flyer*, a store-bought mannequin, dressed appropriately and shortened to fit atop the wing by what project chairman Jack Cherne calls "an operation," aided in finding Orville's true flight characteristics.

For less rigorous posts, such as museum exhibits, figures from Baltimore's Dorfman Company have filled in admirably. Thanks to meticulously sculpted faces, prosthetic-quality eyes, individually implanted hair follicles, realistic urethane skin, and fully articulated armatures (skeletons), each enjoys a range of motion and expression to be envied by a generation of surgically misadvised actresses. Dorfman Wrights can be found in the Owls Head Transportation Museum in Maine and the Thomas P. Stafford Air and Space Museum in Oklahoma, among other places, and

should not to be confused with a half-scale dummy carved from pine two-by-eights at the Wilmington, North Carolina airport or the Ohioan who bills himself as America's only Orville impersonator.

Though their construction may vary considerably, one thing's for certain: A Wright worth looking at is a Wright dressed to the nines. "The Wright brothers always, even when they were down at Kitty Hawk, wore business suits," the National Air and Space Museum's Peter Jakab says. The son of a fashion designer, curator of the original *Flyer*, and a natty dresser in his own right, Jakab is a man to be trusted on such issues. He personally replaced 1940s-era attire on the *Flyer*'s plaster Orville when the figure was lightened in 2000—its heft was denting wing fabric and stressing the delicate ash ribs underneath.

"In those days the typical men's business suit had a very high collar, short lapels, and five or six buttons down the front," Jakab explains, referring to the mannequin's new 38-Regular duds. Orville, who was five foot eight and 140 pounds, would have worn the same size.

Among reproduction Wrights, however, the College Park, Maryland Aviation Museum's animatronic Wilbur stands wholly without peer. I'd been so intrigued by him, in fact, that I made a special trip just to make his acquaintance. Dressed smartly in a tweed cap, black tie, and gray pants, and surrounded by a workbench and tools, historic photos, and personal possessions, he did not disappoint.

"Oh, hello! Sorry—I didn't realize you were here!" he began, startling a child who



Plaster imposter: The National Air and Space Museum's Orville Wright mannequin perpetually pilots the original *Flyer* through its first few seconds aloft.

had tripped his motion sensor. The boy paused and stared uneasily at the robot stranger, but Mr. Wright, circa 1909, hardly took notice. Masticating his words with life-like teeth, swaying his hips to accentuate phrases, and courteously shifting his unfocusing blue eyes to address the entirety of a phantom crowd, he politely offered to walk me over to a replica of the Military Flyer he and "Orv" demonstrated on the museum grounds. I found him every bit on the charming side of undead—sentiments not exactly echoed by everybody.


Shortly before the facility's 1998 opening, Park Police summoned Cathy Allen, then the museum's history coordinator, to unlock its doors so that an officer could check out an intruder alarm. Allen, fresh from bed, arrived to find Sergeant Rick Reichard already waiting. She opened the museum for him and disappeared into the staff offices to switch on the gallery lights. Reichard was headed through a dark corridor when a threatening figure in a white shirt approached him. After hearing muffled yelling, Allen ran out to find Reichard crouched with his gun drawn, frozen in disbelief. She froze too.

"Oh, hello! Sorry—I didn't realize you were here!" Wilbur sang out.

—S.B. Goldberg

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# Miracle

Inventions seldom resemble the refined devices that evolve from them. Robert Goddard's first rocket looked like a moonshiner's still. The first transistor could have been the product of some eighth grader's soldering gun.

When they began experimenting with controlled, powered flight, the Wrights had no idea what the airplane would become. In fact, no one could have gazed at their 1903 *Flyer* and imagined what airplanes would look like after a hundred years.

Nor could anyone who witnessed that December 17, 1903 hop of 120 feet from one patch of sand to another have known what the airplane would come to mean to the world. Not until the second world war was over did it become clear that the airplane was evolving into the preeminent form of civil transportation, moving people and everything else.

Military aircraft have been one of the foremost examples of technological development aimed at extracting maximum performance. Tactical aircraft fly fast, make plenty of noise, and draw a lot of attention, but in this century of flight, humankind in overwhelming numbers has availed itself of the airplane mainly for the simple act of going somewhere—it's the one way aviation touches most of us. AvData, a Wichita, Kansas company that

maintains a census of aircraft populations, estimates the current size of the civil fleet worldwide at about 400,000—five times the military count. In the United States the disparity is even greater: 285,000 to 13,170 (roughly 20 to one).

The growth of air transportation began to accelerate after Charles Lindbergh's 1927 solo transatlantic flight demonstrated the value of the airplane for commerce. Once the turbojet engine graduated from the military environment, which accepted greater risks in its use, to the grinding daily test of reliability that is modern airline operations, the technology multiplied the productivity of the airliner, and air fares became affordable to almost everyone. The jet engine also allowed designers to scale up airliners to jumbo size—another incremental economic bonanza—and there seems to be no upper limit to their growth.

Once the jets arrived, we fell head over heels in love with flying. Jet airliners took us far above the weather, making most trips utterly sensation-free. Oh, we may feel a brief acceleration on takeoff and a jolt or two on landing, and if we should fly through a little turbulence, chances are the captain will tell us how sorry he is for the "bumpy air." But for the most part, the only thrills aboard come from the in-flight movie.

A hundred years after the first



flight, we expect to leave one coast of the United States and reach the other six hours later, to disembark halfway around the world after less than a day of flying, and to rely on air travel to let us freely enter all but a handful of nations to conduct business or pursue pleasure. Destinations advertise the thrill of being there, while the actual trip by airplane has become a footnote. There is nothing magical, after all, about any of this; we live in a time when seat-miles are just a commodity. (And by the way, we also expect fares to stay flat year after year.)

The airplanes that carry us to the farthest reaches of the globe have become as predictable as a high school physics experiment. Engines run seemingly forever, with tens of thousands of hours stretching between major overhauls. The applied sciences of aerodynamics and manufacture are so refined that before the first metal is cut, the performance of a given part or system can be predicted within a percentage point. The softer disciplines, such as interior design, ensure that lighting, textures, and colors soothe us and immerse us in familiarity, and so each flight seems the same as the last.

It has taken us a hundred years to do it, but when you compare air travel today to the way our grandfathers got around in 1903, it's not an exaggeration to say that we've created the

perfect transportation system—"perfect" as defined by: so little room for improvement that improvement may well not be worth the trouble. And if the price of perfection is that the thrill is gone, well...so be it, we say. When it comes to flying, we don't like surprises. If both Orville and Wilbur experienced jolts of adrenaline during their first flights, we'll have none of that, thanks.

Maybe the biggest change in us after 100 years is that we hardly give the role flight plays in our lives a second thought. So it's not easy to persuade anyone in the year 2003 to look upon all that has happened as some kind of miracle. If we paused for just a moment to think about it, though, a miracle is exactly what it is. We human beings may have invented the airplane, but it, in turn, has reinvented us.

—The editors



PHOTO ILLUSTRATION DAVID PETERS/ALL PHOTOGRAPHS: NASM AND BOEING



# Meeting Wilbur and Orville

A BIOGRAPHER'S REFLECTION ON THE IMPORTANCE OF FAMILY.  
BY TOM D. CROUCH



*In 1902 the brothers took turns: When Orville flew, Wilbur launched, aided by friend Bill Tate (at right).*

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I have devoted the better part of 30 years to the study of Wilbur and Orville Wright and the invention of the airplane. I have written several books on the subject, and more articles than I care to count. I have no idea how many lectures I have given with titles like “Why Wilbur and Orville?” The producers of documentary films have enlisted me to serve as a “talking head,” describing the life and work of the famous brothers from Dayton. I have even appeared in an IMAX film, my head five stories tall, describing the Wrights’ achievement.

You might imagine that I would give almost anything to step back in time and join the four men and a boy who watched Wilbur and Orville Wright fly a powered airplane for the first time. You would be wrong. I would not find many surprises, standing around with my collar turned up against the wind blustering across the Kill Devil Hills on the morning of December 17, 1903. The Wright brothers kept a meticulous record of each of the four flights: times, distances, wind speeds. In later years they provided lucid and engaging accounts of their first powered flights. There are even photographs of three of the flights, including the famous one taken by John T. Daniels, one of the witnesses, at 10:35 a.m., just as Orville lifted the airplane off the ground for the first time.

Nor would I waste the opportunity to spend a few hours

with Wilbur and Orville by choosing to witness any of the glider trials, which they conducted in 1900, 1901, 1902, and 1903. Thanks to my friend Rick Young, I have been there, and done that—or almost. Rick, a Virginia restaurateur, has built and flown replicas of the three gliders that were the Wright brothers’ stepping stones to success (see “The Thrill of Invention,” Apr./May 1998). All of this flying has been done in one place: Jockey’s Ridge, the largest single dune on the East Coast, four miles south of the Kill Devil Hills.

Today at the site of their experiments stands the Wright Brothers National Memorial, a wonderful place to visit. You can see full-scale models of the 1902 glider and the 1903 airplane, and Ranger Darrell Collins will describe the events of December 17, 1903, in a manner guaranteed to inspire you. You can peer into reconstructions of the two sheds in which the brothers lived and worked on this remote stretch of coast. Of course, you will want to hike up to the great monument on top of what was once the big Kill Devil Hill. Unfortunately, the creation of the monument required that the shifting sands so familiar to the Wrights be transformed into a very different landscape. Wilbur and Orville would

*By 1909, they were famous; 7 Hawthorne Street, a mecca for aspiring airmen.*



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*Nieces and nephew:  
Leontine (front) and  
Ivonne Wright, towed  
by brother Milton.*

no longer recognize the place. They would feel right at home, however, on Jockey's Ridge, now a North Carolina state park. Rick Young began flying his first 1902 replica from the ridge close to a quarter of a century ago. Fortunately, he invited me along on quite a few occasions. The flights have been reenactments in the truest sense. Civil War reenactors will always be thwarted in their desire to taste something of the life of the soldier. No one is shooting at them. Flying Rick Young's gliders, on the other hand, one experiences precisely what the brothers did.

Thanks to Rick, I have felt Wright gliders come alive in the wind. Watching others on his team fly them is like seeing Wilbur and Orville's wonderful glass plate negatives spring into motion and living color. It is one thing to sit in a library and read what the Wrights had to say about a problem with one of their machines. It is something else again to see that problem with your own eyes, standing ankle deep in the sand, puzzling over what just happened. Nor had it ever occurred to me how difficult it was to shlep those gliders back up the dune for the next flight until I had done it myself. The hours, days, and weeks that I have spent with Rick and his gliders have shaped, at the most fundamental level, what I think and say about the Wright brothers.

I first began to think about the Wrights in a serious way in 1970, when I was in graduate school. My timing was impeccable, for the scholars who laid the foundation for our

understanding of the invention of the airplane and the early history of flight were still active. My mentors included Marvin W. "Mac" McFarland, chief of the science and technology division at the Library of Congress and the man who had edited the classic two-volume edition of *The Papers of Wilbur and Orville Wright*.

I was sitting at a desk in the old Library of Congress manuscript reading room one day in the early 1970s when Mac walked up and handed me the address and telephone number of Ivonne Wright Miller. Until then, it had not occurred to me that the little girl with the blond curls peering impishly out of some of the Wright family photographs might still be living. Mrs. Miller was one of the Wright brothers' nieces, born in 1896. Mac explained that the Library of Congress did not have all of the Wright papers. In 1948, library officials had taken only the most important items that the heirs of Orville Wright offered to them. Mrs. Miller and her husband, Harold "Scribze" Miller, still had a basement full of historical treasure.

I called Mrs. Miller the next time I was home visiting my parents in the Dayton area. She invited a young grad student whom she had never met into her home, and she turned me loose to dig through the boxes in her basement. There were priceless family papers: the diary that Wilbur and Orville's father, Bishop Milton Wright, had kept for over half a century; family correspondence and genealogical records dating back to the early 19th century; the report cards and school papers of all the Wright children, including the inventors of the airplane; original photographs; box after box of financial records; and most of the Wright broth-

ers' library, complete with their handwritten notations on important aeronautical papers. I was only faintly aware of it at the time, but my career was born in that basement.

More important than all of that was the opportunity to sit at the kitchen table at the end of the day and have tea and cookies with a woman who could remember the day, just before Christmas, 1903, when Wilbur and Orville returned in triumph from Kitty Hawk. The inventors of the airplane were her babysitters. They had built and flown little helicopter models to entertain her. She had flown with her uncle Orville in 1911; been married in his Dayton home, Hawthorn Hill, seven years later; and served as his unofficial hostess for two decades. Her husband was one of the executors of Orville Wright's estate.

While I was always conscious of the fact that Mrs. Miller had once lived right around the corner from her uncles, aunt, and grandfather, the reality of the thing occasionally came to me with stunning clarity. Working my way through a box of Wright papers at the Library of Congress one day, I came across a small notebook in which Orville Wright had kept the all-important record of their 1902 glider flights; on its pasteboard back cover, printed twice in childish block letters, was the name "Ivonette." I immediately called Mrs. Miller and asked her about it. She remembered, as she always did. She had turned six that year, and had started school. Her uncle had asked her what she was learning. She replied that she could write her name. Come over here, he said, offering a knee, and show me. And now I held that long-ago signature in my hand. I knew the woman that little girl had become. To this day, it takes my breath away.

Her memories were a priceless gift, freely given. She offered me insight that I could have obtained in no other way. Sometimes understanding came at surprising moments. Once, when I was scheduled to come home to Dayton to give a talk at Wright State University, she called and suggested that this time, instead of staying with my parents, she would arrange for me to spend the night in Hawthorn Hill, now VIP quarters for the National Cash Register Company.

It was a wonderful experience. I got to sleep in Orville's bed, bathe in his famous circular shower, and prowl his study, the only room in the house that remained as it had been at the time of his death in 1948. I pored over a scrapbook that I had never seen. I sat in his reading chair. He had drilled a vertical hole in one arm of an overstuffed chair and inserted the long pole of a music stand that he used to hold his book. There, on the side table, as though he had just stepped out of the room, were his reading glasses, with one

temple removed so that he could put them on and take them off more efficiently.

Before the house was built, Orville had gone over every inch of the blueprints with the architect and made a great many changes. He had sketched details just the way he wanted them, including the way in which the carpet was to fit around the hearth. When the specially woven carpet arrived from Europe and did not fit, he sent it back.

Ivonette explained that when Orville lived here, there had been a cistern on the roof to collect rain water, which was piped through the back of the ice box so that he could have ice water constantly on tap. The only controls for the furnace were in his bedroom. He took great delight in the fact that he was the only one who could master the intricacies of the plumbing and electrical systems. Sitting there that evening, it occurred to me for the first time that this house had been Orville Wright's machine for living. He had only really been

*Neighbors Lester, Paul,  
and Willie Henderson  
may have helped Wilbur  
fly his 1899 kite.*



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*With Wilbur beside her, sister Katharine glanced at Orville before a flight.*

comfortable in an environment that he had designed himself and which he could completely control. For a biographer, it was a defining moment,

one of the many that I owed to Mrs. Miller.

She introduced me to other members of her family. I met her younger brother, Horace "Bus" Wright, and his wife Susan. In 1911, when he was 10, Bus traveled to Kitty Hawk with his uncle to test what proved to be the first glider in history to achieve soaring flight. On one of those flights Orville remained in the air for nine minutes and 45 seconds, a record that would stand for a decade.

I treasured a friendship with the late Wilkinson Wright, the son of Ivonette's older brother Milton. When he was a young man in the 1930s, "Wick" and his cousins had spent summers with Orville at his vacation home on an island in Canada's Georgian Bay. As he told it, however, there was little vacationing going on. "Uncle Orv" kept his grandnephews busy shifting the location of buildings on the island, building a "junction railroad" to bring luggage up from the beach to cabins on the bluff, and performing general chores.

The opportunity to know members of the Wright family, their wives, children, and grandchildren, has been one of the great pleasures of my professional life. It occurred to me many years ago that I knew far more about their family than I did about my own. Relatives further back than my grandparents are only names to me, or unfamiliar faces in fading photographs. I can, on the other hand, recite from memory much of the Wright lineage back to the 17th century. I can tell you something about the personalities of family members, including the two Wright brothers you never hear mentioned—Ivonette's dad, Lorin, and first-born Reuch-

lin. I can tell you how they lived and died, their triumphs and disasters. I have read the letters and diaries of generations of Wrights. I am certain that Orville Wright, that most private of men, would be very unhappy knowing how familiar I am with his inner life and that of the other members of his family. He did what he could to discourage would-be biographers. I find it hard to believe that he would accept anyone as nosy as I am.

For all of that, I would know more. Several years ago one of my favorites of the present generation of the Wright family introduced me to an audience as "our family Boswell." I could not have been more proud. At the same time, I have had none of the advantages James Boswell had in spending years in the constant company of the writer Samuel Johnson. He traveled with him, discussed everything under the sun, met his friends and family. I would be happy just to spend an afternoon in the company of Wilbur and Orville.

As noted, I would not choose a time when they were preoccupied with their experiments. Rather, I would stroll into the Wright Cycle shop at 1127 West Third Street in Dayton, Ohio, on any afternoon in early August 1899. Just three months before, the brothers had announced their interest in flight for the first time in a letter to the Smithsonian Institution requesting information on the state of the aeronautical arts. Recognizing that other pioneers had built wings that would lift them into the air, and that propulsion was an issue that could wait, they quickly decided to focus on aeronautical control.

Standing in this very shop that spring, idly fingering a long, narrow box that had contained an inner tube, Wilbur had come upon the notion of moving the top wing of a biplane fore or aft of the bottom wing, and even inducing a helical twist across both wings in a way that would enable a pilot to control the movement of the center of pressure

on the wing, and thus the motion of a flying machine. He built a small skeletal model of such a biplane out of bamboo slivers, rigged with thread, just to clarify in his mind the mechanics of the thing. Then he built a biplane kite with a five-foot wingspan to test the principle.

He walked out of the bike shop one day late in July with the kite carefully tucked under his arm. He walked four or five blocks west on Third Street, then turned north for two blocks. Along the way, he collected a crowd of boys who had abandoned their own kite flying activities to follow Wilbur. Arriving at an open field at the corner of West First Street and Euclid Avenue, near the Union Theological Seminary, he set up the kite and unwound the four 20-foot lines that would control its motion.

Wilbur asked one of the boys, Johnny Myers, to hold the kite as far above his head as he could and to let it go when instructed. "There was quite a big wind that day," Myers reported many years later. "I recall that when he tilted the planes, the kite came down very rapidly." With a bit of practice, Wilbur was able to maneuver the kite in the air. It was a tricky business, however. Once, when he allowed the lines to go slack, the kite darted toward the ground, scattering the young onlookers. On that quiet summer afternoon, Wilbur Wright had taken the first step toward the invention of the airplane.


I have a kite like that. A friend who is far better with his hands than I am built it for me. It is not easy to fly. Without some weight in front of the leading edge, I can't keep it in the air at all. For a long time, my record duration aloft was 20 seconds. My kite, and all of the other replicas that people have built, are based on a simple drawing that Wilbur sketched one morning before testifying in a patent suit. I would like to see what his kite was really like. And I would like to ask how long he really kept it in the air on that first day. Maybe he could give me a few tips.

I would not choose to visit on the day he flew the kite, because Orville was away on a camping trip, and I would want to meet them both. I would like to shake hands with the brothers, long before they tasted fame, at a time when the possibility of actually succeeding where so many others had failed was the most distant dream.

I would like to hear their voices. No recording of either of them has survived. I know what others have said about their personalities. Members of their family have described them to me at length. I have read what they wrote, and drawn my own

conclusions. I would simply like a reality check on my assumptions about these two men, to whom I have given so much thought.

I would like to walk home with them, to the house at No. 7 Hawthorne Street. What would I not give for the opportunity to chat for a few minutes with their father, Bishop Milton Wright, the man who was so important in shaping the lives of his children and through them the history of the 20th century? I would certainly not pass up the chance to spend at least a few minutes with their sister, Katharine. And I would want to walk the neighborhood, getting a feel for the few blocks along West Third Street that the Wrights knew so well.

Of one thing you can be certain. My visit to the West Dayton of 1899 would not be complete without a walk around the block to Horace Street and a visit with a three-year-old charmer named Ivonette. For my money, that would be an afternoon in the past well spent. 

*Brother Lorin was a  
bookkeeper and father  
of four: Milton,  
Horace (not shown),  
Leontine, and Ivonette.*



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he National Air and Space Museum is fortunate to have the artifact that inaugurated the aerial age—the 1903 Wright *Flyer*. The craft that hangs in the central place of honor in the Museum’s Milestones of Flight gallery is the actual airplane that clattered over the wind-swept beach at Kitty Hawk on that historic December morning one hundred years ago.

The Wrights’ first airplane is an icon of ingenuity and technical creativity. It is not only the centerpiece of the Museum; it is also one of the signature artifacts of the Smithsonian Institution. But, of course, when Wilbur and Orville built and flew the *Flyer* in 1903, it was not a national treasure. To the Wrights, it was essentially a research tool; they built it merely as one step in the process of creating a practical airplane. Its transformation into a priceless piece of American heritage, displayed in the nation’s capital, would take some interesting twists and turns.

The *Flyer* was the culmination of experiments that began in 1899 with a five-foot-wingspan kite the Wrights built to test their breakthrough concept for lateral control, which they called wing-warping. The brothers realized that the key to successful flight was controlling the airplane’s movement in three axes, vertical, lateral, and longitudinal, and that achieving this control aerodynamically was essential to building an airplane large enough to carry the weight of an engine, a pilot, and, ultimately, a payload. Previous experimenters had attempted to control their gliders by having the pilot shift his body weight, the same technique used to maneuver a modern hang glider, but that approach severely limited the size of

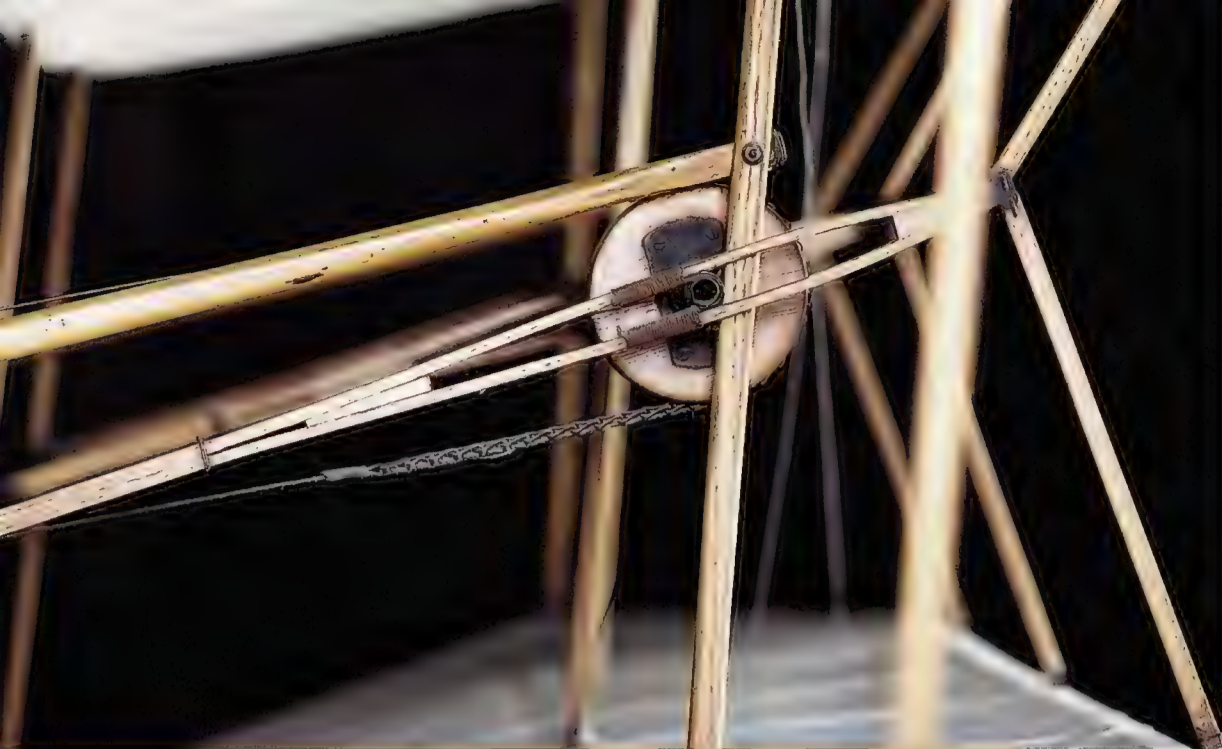


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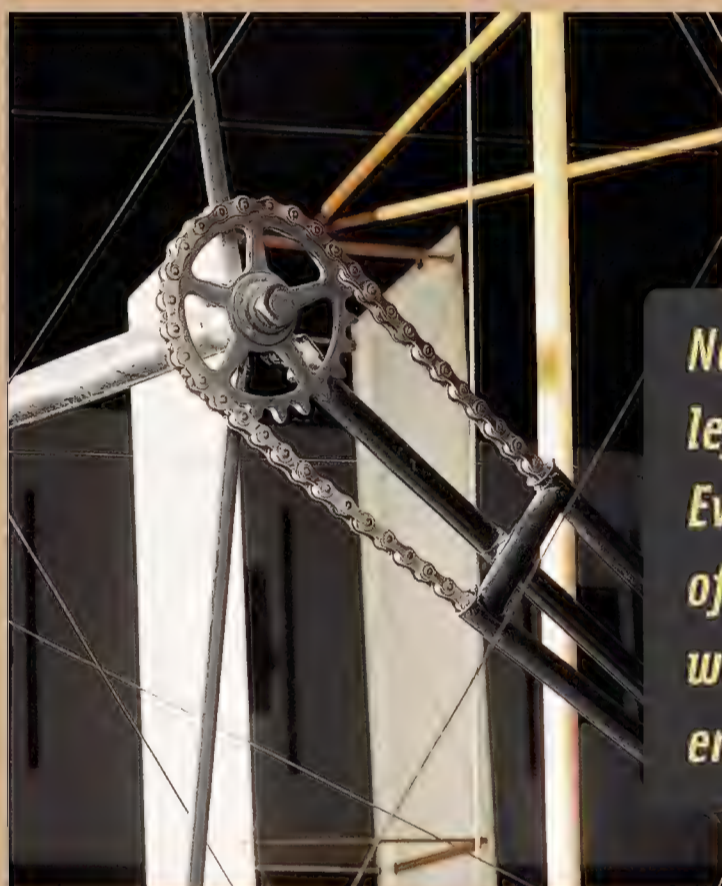
# RIGI NAL

*The first airplane commands center stage at the National Air and Space Museum 100 years after it made history at Kitty Hawk.*

THE WRIGHT FLYER’S JOURNEY FROM INVENTION TO ICON. BY PETER L. JAKAB



*A chain and pulley controlled the elevator (above). The transmission system for each propeller required a chain and sprocket.*



CAROLYN RUSSO (2)

**Nothing was left to chance. Every aspect of the airplane was carefully engineered.**

*After the Flyer left London, the U.S. Navy trucked it from New Jersey (below) to Washington, D.C., in 1948.*



NASM

the craft. With the Wrights' wing-warping method, the wing tips on one side were angled upward while the wing tips on the other side were angled downward. This created a higher angle of attack on one side, which in turn produced greater lift on that side. Controlling the change in lift on one side or the other enabled the pilot to balance the wings aerodynamically and to bank into a turn. Today, this maneuvering is accomplished with ailerons, control surfaces on the trailing edges of the wings, but the concept is the same, and it originated with the Wrights. The brothers' 1899 kite also featured a trussed-biplane design.

Altogether, these elements formed the nucleus of the powered airplane that would carry the Wrights into the air in 1903. The 1899 kite, Wilbur and Orville's first critical step toward flight, does not survive.

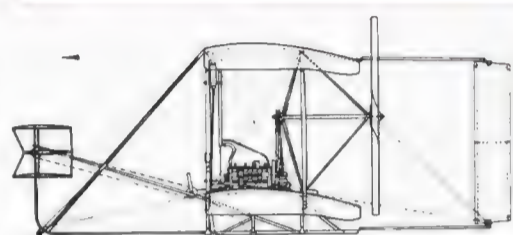
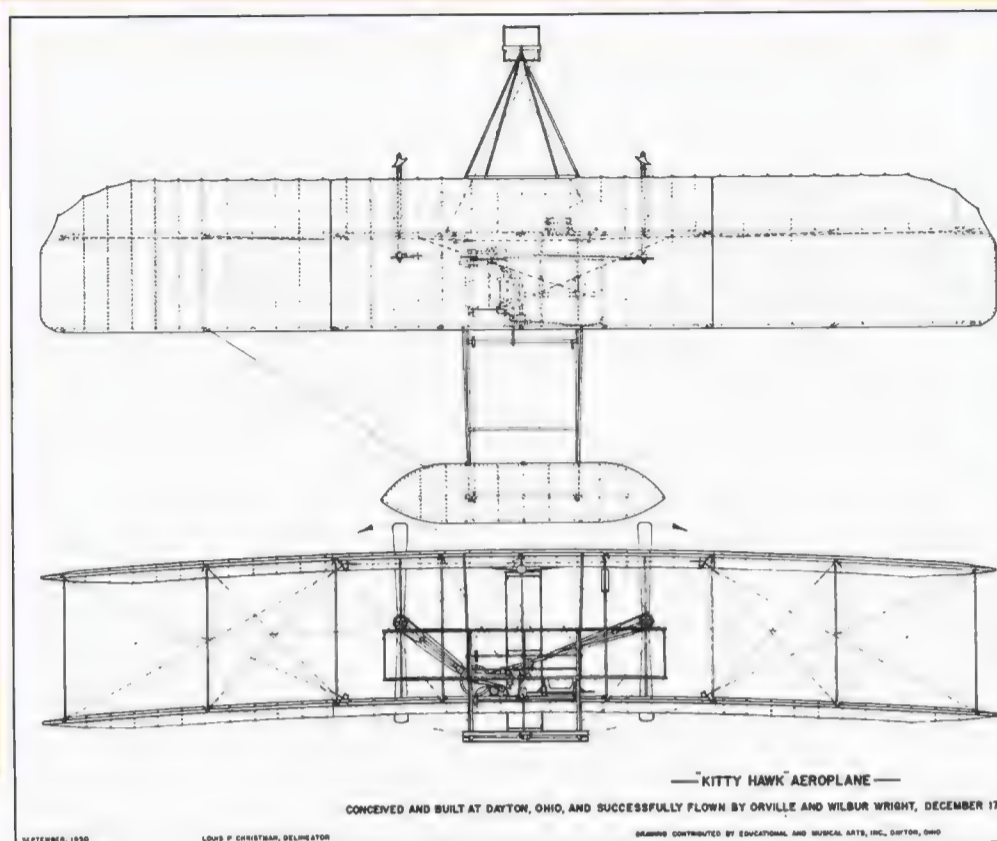
After experimenting with that kite, the brothers produced three full-size, piloted gliders between 1900 and 1902. Each aircraft incorporated the lessons learned from the last, with the result being a single, evolving design. Continuity of design was one of the keys to the Wrights' success.

They did not jump from one radically different idea to another. Equally important was the research they conducted in late 1901 with model airfoils in a wind tunnel; these studies enabled them to gather the aerodynamic data needed to perfect their wing design. The instruments they used and the manner in which they performed the experiments laid the foundation of modern aeronautical engineering. This contribution by the Wrights was as valuable to the future of aviation as the creation of the airplane itself.

By late 1902, Wilbur and Orville had solved the basic control and aerodynamic problems and developed a design for a powered heavier-than-air craft. Orville confidently wrote to a friend in June 1903, "Isn't it astonishing that all these secrets have been preserved for so many years just so we could discover them!!"

After some highly original and imaginative research to create the world's first aerial propellers, and the construction of a small lightweight gasoline-powered engine, the Wrights spent the spring of 1903 building an airframe for their first powered craft. Nothing was left to chance. Every aspect of the airplane was carefully engineered.

In what had become an annual late-summer/early-fall ritual, the Wrights then set off on their fourth trip to Kitty Hawk, a fishing village on the Outer Banks of North Carolina that had been the site of all their flight testing. They had months of bad weather, but they used the time assembling the *Flyer* and resolving problems with its engine and transmission system. Finally, in mid-December, they were ready to begin flight tests. The harsh Kitty Hawk winter was descending quickly, but the brothers were optimistic. "We will not be ready for a trial for several days yet on account of having decided on some changes to the machine," Orville wrote their mechanic, Charles Taylor. "Unless something



*During the 1984-1985 restoration, draftsmen measured the Flyer and created a set of drawings that improved upon those made in 1950 in Dayton (left).*

NASM (2)

breaks in the meantime we feel confident of success.”

On December 14, they were finally ready for a trial. A toss of a coin determined that Wilbur would make the first attempt. Surprised by the sensitivity of the elevator, Wilbur over-controlled the *Flyer* on takeoff. It nosed up sharply, stalled, and smashed into the sand. The mishap did not deter them. Later that day Wilbur wrote home: “There is now no question of final success.” Orville affirmed their certainty with a succinct telegram to his father the next day:

Misjudgment at start reduced flight to hundred and twelve [feet]. Power and control ample. Rudder only injured. Success assured. Keep quiet.

Repairs were completed in three days. By 10:30 a.m. on December 17, everything was ready and the engine was started. It was now Orville's turn in the pilot's position. Rising slowly into a 27-mph wind, the younger Wright sailed forward 120 feet in 12 seconds. For the first time in history, a human being had flown a powered, controllable craft.

The brothers made three more flights that day, taking turns as pilot. The best, with Wilbur at the controls, covered 852 feet in 59 seconds. After that final flight, a strong gust overturned the *Flyer*, tumbling it across the sand and badly damaging it. The world's first airplane would never fly again. Having served its purpose as a research tool, the 1903 Wright *Flyer* entered a new phase of its history.

Wilbur and Orville had not saved any of their earlier gliders; when they were finished testing them, they simply left them at Kitty Hawk. They, did, however, recognize the historic significance of the first powered airplane, though they did not immediately consider it the treasure we do today. They disassembled it, put it in crates, and shipped those back to Dayton, where they were stored unopened for 13 years. The *Flyer's* hibernation included two weeks under water and mud during a 1913 flood. In 1916, Orville re-

assembled the aircraft for the first time since Kitty Hawk for a brief public display at the Massachusetts Institute of Technology in Cambridge.

The *Flyer* began to acquire the status of a national treasure in the 1920s as a feud developed between Orville and the Smithsonian Institution. The dispute centered on the Smithsonian's public display of the aeronautical achievements of its former Secretary, Samuel P. Langley, and the Institution's reluctance to credit the Wright brothers as the true inventors of the airplane. Langley had tested his tandem-wing aircraft, the Aerodrome, on October 7, 1903, and again two months later. Both times the Aerodrome failed to achieve sustained flight, instead crashing immediately into the Potomac River.

Langley died in 1906, but in 1914, Smithsonian Secretary Charles D. Walcott, a good friend of Langley's, authorized aircraft inventor Glenn Curtiss—a Wright competitor—to flight test the Aerodrome in Hammondsport, New York. Curtiss' tests were overseen by Albert F. Zahm, who was in charge of the Institution-backed Langley Aerodynamical Laboratory; the cost of the tests was covered by the Institution, which also paid Curtiss \$2,000 for his services. From the waters of Lake Keuka, Curtiss was able to make a series of short hops in the craft, which had been equipped with floats. The Aerodrome had been substantially modified in other ways too, so it was hardly identical to the one that had fallen so pitifully into the Potomac 11 years before. Still, Walcott labeled the Aerodrome, on display in the Smithsonian's National Museum, as “Original Langley flying machine, 1903, the first man-carrying airplane in the history of the world capable of sustained free flight. Invented, built and tested over the Potomac River by Samuel Pierpont Langley in 1903. Successfully flown at Hammondsport, N.Y., June 2, 1914.”

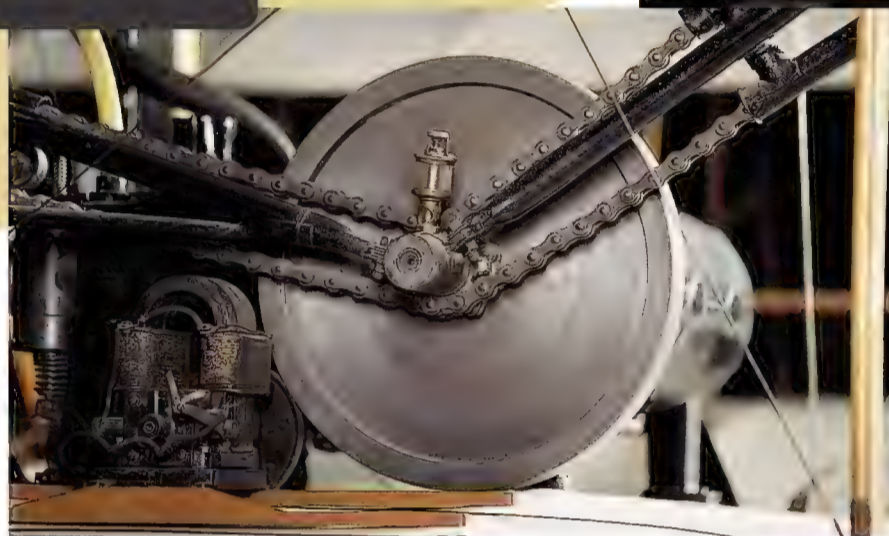
In 1925, Orville tried to use the *Flyer* as leverage to shame the Smithsonian into correcting its stance. He announced



The elevator control stick (above). The engine's heavy flywheel (right) absorbed the vibrations of the rotating crankshaft.

*"It is a little as if we had before us the original wheel."*

The muslin covering on the Flyer today dates from 1985 (right), but the wooden struts and wire braces between the biplane wings (opposite) flew in 1903.



CAROLYN RUSSO (3)

that he would loan it to the Science Museum in London. Surely, Orville believed, the American people would not stand to have the world's first airplane, built in America, by Americans, exiled to a foreign land. The assemblage of wood, wire, and fabric that two decades earlier the brothers had considered only an engineering research platform was now the symbol of their world-changing contribution to humanity.

But the Smithsonian refused to retract its claims about Langley, and to properly credit the Wrights, so Orville prepared to send the *Flyer* to England. Before displaying it at MIT in 1916, he had repaired the elevator, rudder, wing ribs, chain guides, and other parts that had been damaged when the airplane was overturned at Kitty Hawk. He had also replaced some engine components and portions of the fabric covering. Now, readying it for display abroad, he replaced all of the covering. The *Flyer* arrived at the Science Museum in 1928.

Orville lamented the entire situation. "In sending our original 1903 machine to the Science Museum, London, I do so with the belief it will be impartially judged and will receive whatever credit it is entitled to," he wrote in the March 1928 issue of the journal *U.S. Air Services*. "I regret more than anyone else that this course is necessary."

In the face of Orville's action, the Smithsonian continued to dodge the issue. Secretary Charles Abbot—Walcott's successor—offered only an unsatisfactory compromise on the language of the label accompanying the Langley airplane, and did so, in Abbot's words, "not in confession of error, but in a gesture of good will for the honor of America." These words only stiffened Orville's resolve.

In 1942, the Smithsonian finally published a retraction of its views on the Langley matter, and in 1943 Orville made

plans to have the *Flyer* returned to the United States and transferred to the Smithsonian for public display. During World War II, the airplane was stored with British national treasures in an underground chamber about 100 miles from London. After the war, Orville agreed to leave the *Flyer* at the Science Museum until restorers could make a copy for display there.

In January 1948, Orville, then 76, died suddenly of a heart attack, leaving it to the executors of his estate to fulfill his wishes and bring the *Flyer* home. It was installed at the Smithsonian in an elaborate ceremony on December 17, 1948, 45 years to the day after its history-making flights. On the occasion, the British ambassador to the United States, Sir Oliver Franks, eloquently summed up the significance of the airplane: "It is a little as if we had before us the original wheel."

Thirty-six years later, in late 1984, the National Air and Space Museum began a restoration of the *Flyer*, the first time it had received any major conservation treatment since Orville Wright had prepared it to go to the Science Museum in the late 1920s. Curator of aircraft Robert Mikesh supervised the work, with Wright brothers expert Tom Crouch providing historical guidance. The curators decided to perform the treatment in the Museum so visitors would not be deprived of the sight of the *Flyer*. Restorers carefully cleaned and repaired the wooden framework. They also removed corrosion on the metal fittings and treated the surfaces with preservative. In order to retain the remaining original paint on the engine but still refinish it, the workers applied a coating of light, inert wax before giving the engine a fresh coat of black paint. If need be, the new paint and wax can be easily removed to reveal the original paint underneath.

During four months of disassembling, cleaning, preserv-




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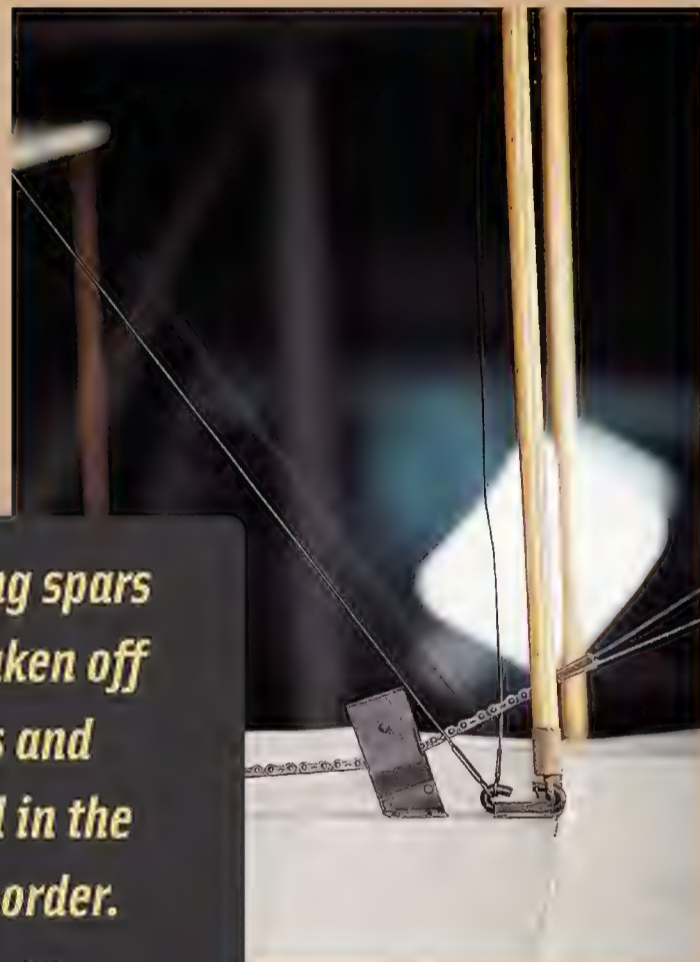
ing, and studying the Wright *Flyer*, the Museum staff learned many things about the famous object. When the fabric covering was removed, details of the structure were better understood, and some interesting markings were revealed. Inside one of the wingtips was stamped the name "Browns." Tom Crouch discovered that S.N. Brown Co. was a carriage company in Dayton, Ohio, and that the wingtips were made from bowed pieces of wood that formed a folding carriage roof. A restoration technician made a similar discovery when the wing spars were taken off the ribs and stacked in the correct order. Written on them was "Wilbur Wright" and the shipping destination of the parts, "Elizabeth City, N.C." Comparison of the fabric Orville had put on in the 1920s with the original 1903 fabric, a sample of which is in the Museum's collection, showed that Orville had sewn the covering slightly differently in 1927. When they applied new fabric in 1985, Museum technicians stitched it using the 1903 pattern, increasing the accuracy of the *Flyer* for subsequent display. Finally, draftsmen carefully measured and documented the aircraft, producing a set of drawings that very accurately represent the aircraft as it exists today.

When Orville had first made repairs and reassembled the *Flyer* in 1916, he had had to replace the engine crankcase, crankshaft, flywheel, and propellers. The 1984-1985 treatment showed the airplane to be in very good condition. Other than the fabric, nothing was replaced, and the airframe is exactly what flew at Kitty Hawk in 1903.

Since coming to the Smithsonian in 1948, the airplane has been taken down from its hanging display only three times: to transfer it to the new Museum building in 1976, to restore it in 1984-1985, and to move it into another gallery during three months of repairs to the skylights in the Milestones of Flight gallery in 2000. This year we will take the *Flyer* down once more, this time to display it for the first time on the floor, in a gallery all its own, along with the most extensive presentation on the Wright brothers the Museum has ever offered. Opening this October, the Museum's anniversary exhibition, "The Wright Brothers & the Invention of the Aerial Age," will provide visitors a two-year opportunity to see the aircraft in intimate detail.

The Wright *Flyer* reflects both the extraordinary accomplishment of two individuals and the enormous potential that resides in all humanity. We owe a great deal to the Wright brothers—their airplane changed the world forever. 

*On December 17, 1948, the 1903 Flyer found its place at the Smithsonian Institution, displayed in the Arts and Industries Building with such artifacts as the flag (background) that inspired Francis Scott Key to write "The Star-Spangled Banner."*



CAROLYN RUSSO

*The wing spars were taken off the ribs and stacked in the correct order. Written on them was "Wilbur Wright" and the shipping destination of the parts, "Elizabeth City, N.C."*

# *the* Wright Fleet

*13 years, 19 airplanes*

*Illustrations by Paul DiMare*



**1903 Flyer** Its wings spanned more than 40 feet and drooped 10 inches at the tips. The world's first powered airplane, it was nevertheless merely a variation of the glider that preceded it.

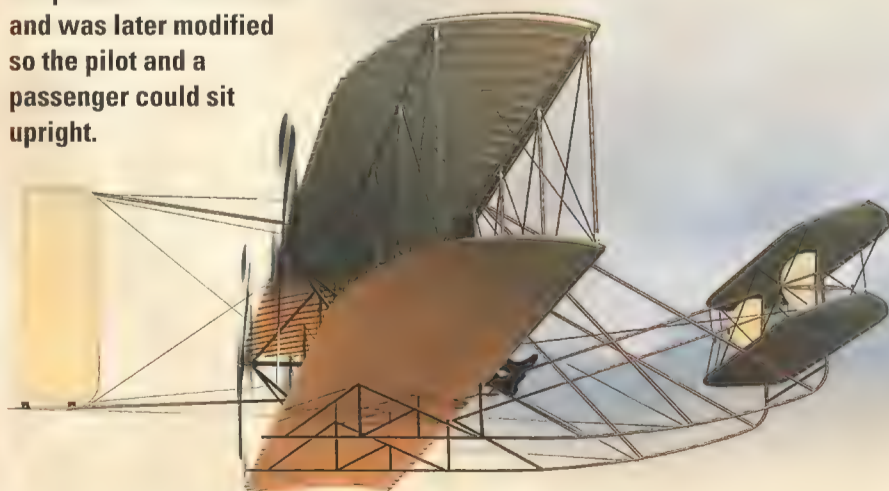
**1904 Flyer** Experimenting, the Wrights decreased the wings' camber, shifted engine, gas tank, and radiator rearward, and used larger propellers.



**1909 Military Flyer**

The U.S. Army Signal Corps offered \$25,000 for a craft that could fly 40 mph and carry two people and sufficient fuel for a trip of 125 miles. The Wrights demonstrated this model at Fort Myer, Virginia, in 1909. Orville flew an average speed of 42.5 mph on a 10-mile round trip, earning a bonus of \$5,000 for the extra 2.5 mph and making the final purchase price \$30,000.

**1905 Flyer** Sturdier than its predecessors (it weighed 105 pounds more), it was the world's first practical airplane. It had larger rudders and semi-circular surfaces between the planes of the elevator and was later modified so the pilot and a passenger could sit upright.



**1909-1910 Model A-B** The 1909 aircraft became a testbed for the positioning of the elevator. The Wrights added a second elevator to the rear; for a time the airplane flew with both. Eventually, they removed the forward elevator.

**1907-1909 Model A**

The Wrights built at least seven two-seat aircraft during this period and with them proved to the world that their airplanes could fly.



Source: *The Papers of Wilbur and Orville Wright*, Marvin W. McFarland, ed., McGraw-Hill, 2001. Notes by the Aeronautics Division of the Library of Congress.



**1910 Model R** A single-seater built for racing, the "Roadster" was fast. One version, the "Baby Grand," with a span of only 21 feet and a 60-horsepower engine, flew almost 80 mph.



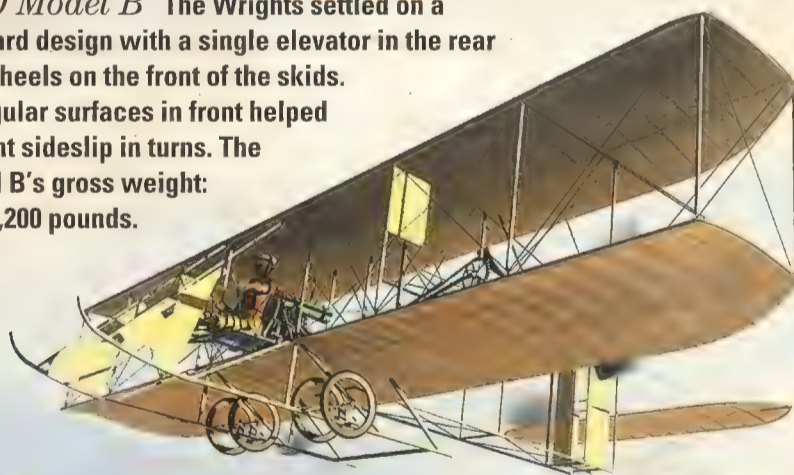
**1912 Model C**  
With less cambered wings, a simplified control system, and forward vertical vanes replacing the Model B's triangular blinkers, this aircraft was to be the new standard, but it was a handful for novice pilots.



**1910 Model B** The Wrights settled on a standard design with a single elevator in the rear and wheels on the front of the skids. Triangular surfaces in front helped prevent sideslip in turns. The Model B's gross weight: over 1,200 pounds.


**1910 Model Ex** The single-seat biplane was slightly smaller than the standard Model B and was used for exhibition flying. It made history in 1911 when Calbraith Perry (Cal) Rodgers, sponsored by the company that manufactured the soft drink Vin Fiz, flew it across the United States. It took him 49 days.

**1913 Model CH**  
The Wrights' first hydroplane, fitted with a 240-pound pontoon.



**1912 Model D** Built for speed, the Model D had a 27-foot span, a six-cylinder engine, and the unfortunate tendency to nose over on landing.






**1913 Model G Aeroboat** The Wrights' only flying boat was designed by Grover Loening under Orville Wright's supervision. The hull was made of wood and covered with a metal alloy treated to prevent saltwater corrosion.



**1913 Model F**

The first Wright model with a fuselage, the F started out with tractor propellers, but they were moved to the rear on the aircraft delivered to the Army in 1914.



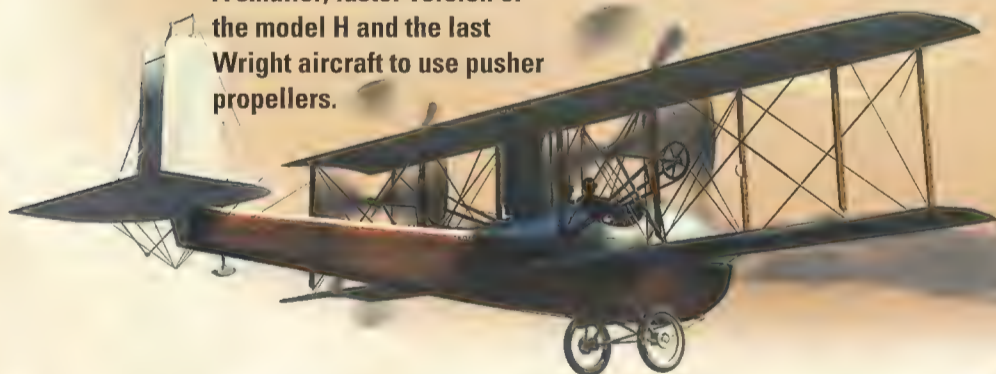
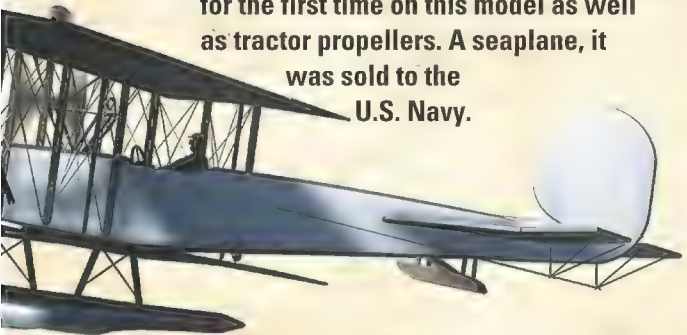
**1913 Model E** The first Wright airplane with a single propeller, the Model E was especially suited to exhibition flying because it was easier than other models to dismantle and assemble.



**1914 Model H** A continuously enclosed fuselage and the capability of carrying 1,000 pounds made the H attractive to the Army as either a bomber or a freighter. According to a 1916 British publication, *Aeronautics*, there was plenty of room in the "spacious cockpit for pilot and passenger and bombs."

**1915 Model HS**

A smaller, faster version of the model H and the last Wright aircraft to use pusher propellers.

**1915 Model K** Ailerons appeared for the first time on this model as well as tractor propellers. A seaplane, it was sold to the U.S. Navy.

**1916 Model L** The last Wright aircraft was a light scout, intended as an improvement of the Model D. By the time of its sale, Orville no longer directed the company.

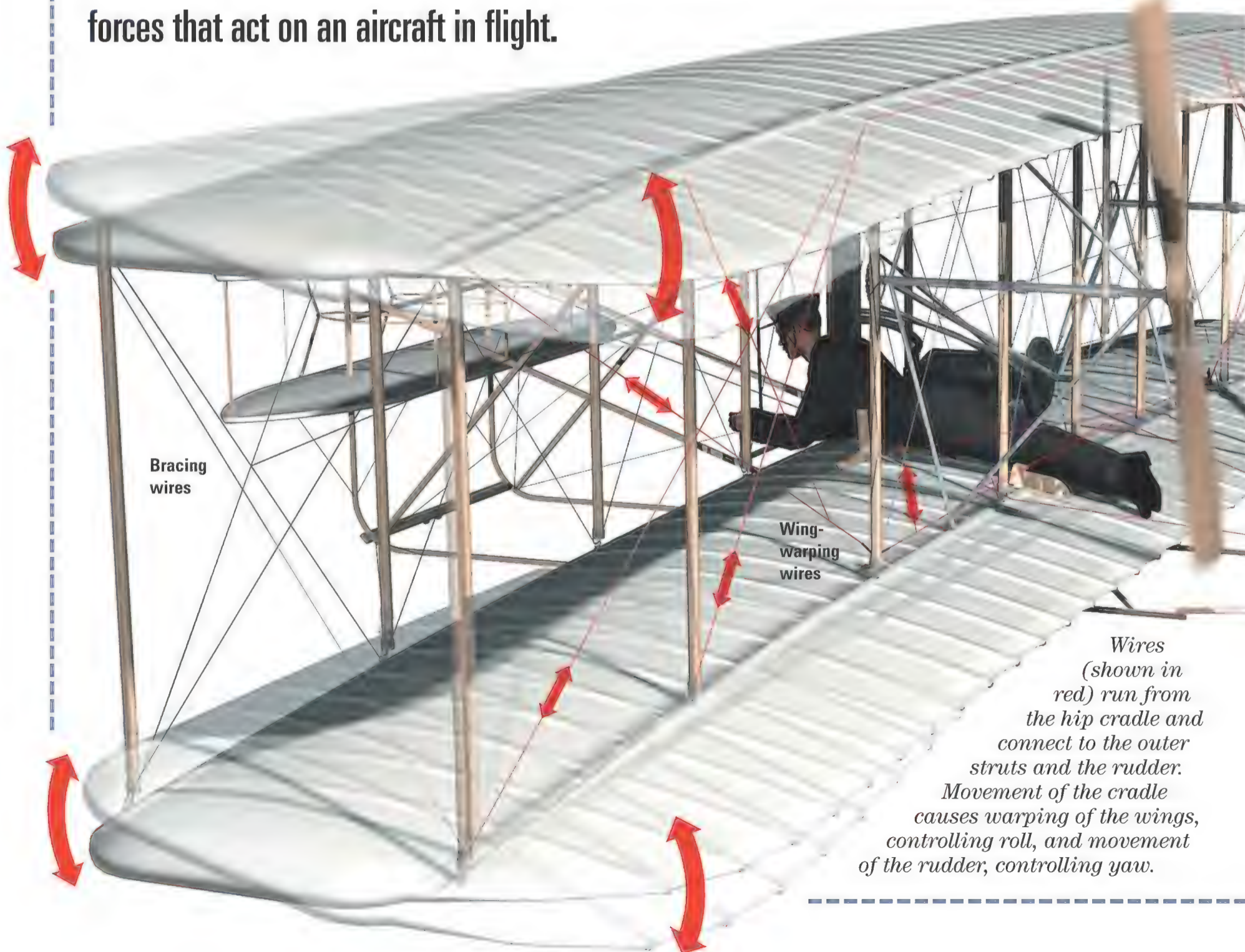


# How Things Work:

# The 1903

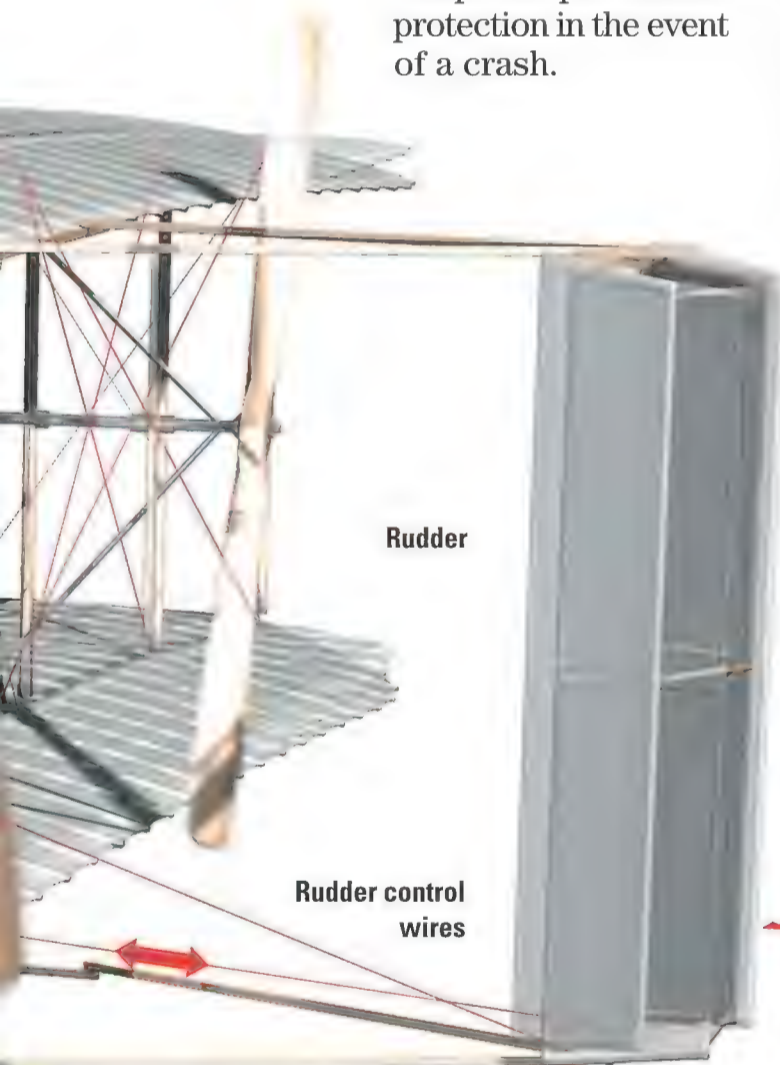
by Phaedra Hise | Illustrations by John MacNeill

Even to pilots, the 1903 Wright *Flyer* is a mysterious bundle of wires and cables that has little in common with today's aircraft. But look more closely at how the machine flies and you begin to see the connections. Crawl over the wing, settle into the hip cradle, and discover the Wrights' ingenuity in identifying and controlling the complex forces that act on an aircraft in flight.



# Wright *Flyer*

Climb in facing the two-surface horizontal elevator. On modern aircraft the elevator and rudder are combined in the tail, but here they are separated: elevator in front, rudder behind. The two elevator surfaces generate lift. They also provide a handy reference point to the horizon, and give the prone pilot some protection in the event of a crash.



The Wrights reasoned that a prone figure piloting the aircraft would create slightly less drag than a seated pilot. You may eat a few mouthfuls of sand on the rougher landings, but that's a small price to pay for flying the world's first airplane. You have half a gallon of fuel on board, enough

to fly for 20 minutes, but your neck will start to ache long before your fuel runs out.

Start the engine, which is at your right, offset from center, by moving the horizontal lever at your right hand to the center position. This opens the cock connecting the fuel line to the engine. Simultaneously, assistants will pull the propellers through in unison. The two propellers, mounted at the rear of the wings, rotate in opposite directions to cancel torque, which tends to pull an airplane in the opposite direction of its propeller's rotation.

A small truck made with the hub of a bicycle wheel supports the craft in the rear; another hub is affixed to the craft at the front. With the engine running and the propellers turning, an assistant releases the restraining wires and you roll on the hubs along a single rail. With the required 20-knot wind on the nose, you will lift off in about 40 feet. Your left hand rests on the elevator control, a small lever attached to a rod running along the leading edge of the lower wing. Pull back slightly on the lever and the connecting rods tilt the elevator assembly in front of you slightly up, creating enough lift to urge the wings upward. (The elevator is very sensitive; use small motions.)

Other aviation visionaries attempted to control flight in only two axes: pitch—nose up and down, and yaw—nose side-to-side. The Wrights were the first to understand the third: roll. Their patented wing-warping system controlled the *Flyer's* movement around its longitudinal axis. Sliding the hip cradle deflects the edges of the wings'

outboard sections and causes the airplane to bank. The center section of the airplane stays rigid as a stable platform for the propeller shafts and transmission chains.

The braided cable attached to the hip cradle zigzags through pulleys placed about two-thirds of the way back along the rear wing struts. When you slide the hip cradle to the right, the cable pulls the right wing tips down and the left wing tips up. The left wing tips, with their increased angle of incidence, generate more lift. The left wings rise as the right wings, with their lift decreased, fall. The airplane rolls to the right.

In the roll, the left wings, with their increased lift, also develop correspondingly increased drag. That makes the left wings fall slightly behind the right wings, pulling the nose to the

## The Moveable Rudder

As a wingtip is warped upward and starts to rise because of increased lift **1**, the lift vector changes direction, and drag increases **2**. Drag slows the forward speed of the high wing, and the low wing begins to slide forward.




### Three-Axis Control

The Wrights' innovation was control in all three axes: pitch, yaw, and roll.

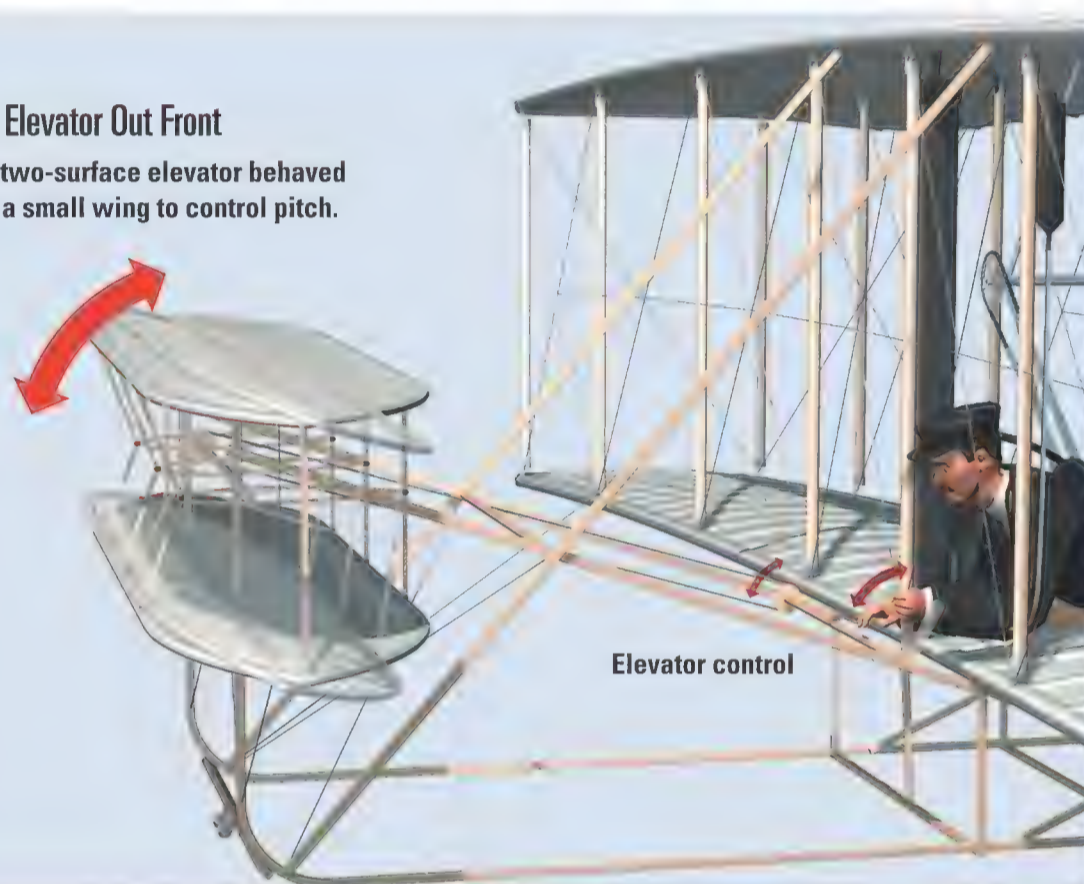


left as the airplane rolls right. The Wrights corrected for this “adverse yaw” by connecting the rear rudder to the wing-warping system. As the airplane rolls to the right, the interconnected cables pivot the rudder so that its trailing edge points right. Acting as an airfoil, the rudder generates enough lift to resist the yaw caused by the slowed left wing, holding the airplane so that the nose continues to point right.

At the end of the flight, you land in the sand on the skids on the *Flyer*'s underside. Most landings break something on the airframe. No matter, the simple ash-and-spruce frame can be repaired much more easily than today's aluminum or fiberglass fuselages. After a day in the shop, the *Flyer* will be ready for another few minutes of flight. 

### The Elevator Out Front

The two-surface elevator behaved like a small wing to control pitch.



The Wrights thought a fixed rudder **3** would be enough to correct for the drag on the higher wing, but in a left turn, for example, the airplane would drift sideways to the left **4**.



A moveable rudder **5** connected to the wing-warping controls created enough force to counter the drag pushing the right wing back and yawing the airplane to the right. The moveable rudder pushed the tail to the right, creating left yaw and a coordinated turn.



# "I have today seen Wilbur Wright and his great white bird."

HOW TWO PRIVATE MEN BECAME THE FIRST INTERNATIONAL CELEBRITIES. BY MARY COLLINS



EN CLAMBERED UP TREES FOR A BETTER VIEW WHILE THE LADIES RAISED THEIR LONG SKIRTS AND RAN DOWN THE GRASSY RUNWAY TO KEEP UP WITH THE CROWD. PEOPLE CAME BY THE THOUSANDS TO SEE THE MOST REMARKABLE SIGHT OF THEIR ERA: WILBUR WRIGHT FLYING AN AIRPLANE OVER THE FIELDS OF FRANCE IN 1908.

HIS PERFORMANCE AND ORVILLE'S LATER EQUALLY DRAMATIC TIME TRIALS AT FORT MYER, VIRGINIA, WERE THE BROTHERS' FIRST OFFICIAL PUBLIC FLIGHTS AND THE FIRST TIME THE MASSES HAD WITNESSED THE WRIGHT AIRCRAFT IN ACTION.

It's impossible today in our technology-saturated society to grasp the awe people felt as the thresher-like sound of the engine filled their ears and the 32-foot-long white wings rose over their heads. They might have imagined that man could fly, but as Orville himself later observed, "Flight was generally looked upon as an impossibility and scarcely anyone believed in it until he had actually seen it with his own eyes."

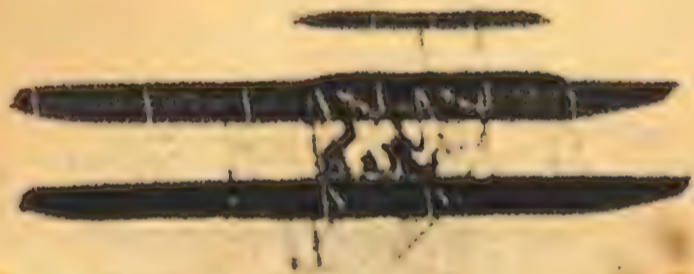
The two men from Dayton, Ohio, seemed an unlikely pair to be the first to build a

workable airplane. Quiet, reserved, extremely devoted to family and a select group of friends, Wilbur and Orville Wright did not relish the limelight. Orv, the dapper younger brother, felt most at home tinkering in the bicycle shop or horsing around with his nieces and nephews. Will read extensively and kept to himself. Captivated

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*After Wilbur's 1908 flights in France made headlines worldwide, Orville put on a show of his own at Fort Myer, Virginia.*

The "Wright Flyer" is a true flying machine. It has no gas bag or balloon attachments of any kind, but is supported by a pair of aero-curves or wings having an area of 510 square feet. It measures a little more than 30 feet from tip to tip and the extreme height is about 20 feet. The engine is placed just behind the wings.



## DAYTON BOYS EMULATE GREAT SANTOS-DUMONT

ORVILLE AND WILBUR WRIGHT BUILD AN AIRSHIP THAT MAKES THREE SUCCESSFUL TRIALS—TESTS HELD IN SECRET ON THE CAROLINA COAST.

News, Dec. 18, 1903 p. 8



ORVILLE WRIGHT.

Gem City Mechanics Who Built a nd

Kitty Hawk, N. C., Dec. 17.

We have made four successful flights this morning, all against a 21-mile wind. We started from the level, with engine power alone. Our average speed through the air was 31 miles. Our longest time in the



WILBUR WRIGHT.

were all made easily and without injury to either the machine or operator. The Wright brothers have been carrying on experiments for the past six or seven years, and have built three previous machines for gliding by means of which they attained proficiency in the control of their apparatus. This year is the first time they have attempted to drive their machine by power.

### THE WRIGHT FLYER.

"Wright Flyer" is a true flying machine, but is supported by a pair of aero-curves or wings.



La Conquete de l'Air aux Etats-Unis.



*Men from the rescue station at Kitty Hawk, North Carolina, served as the Wrights' first ground crew. (Later, royals from Europe vied for the privilege.)*

on an intellectual level by the mysteries of flight, they aggressively picked away at each intricate piece of the problem. They did not, however, want the world to gawk at them while they worked toward a solution.

But after Wilbur completed his first controlled turn over the field at Le Mans, France, the brothers could no longer hide from the public eye. To their chagrin, they had become the century's first international celebrities. For years their secrecy had made many doubt their claims of success at Kitty Hawk, but after Wilbur's flights in France, the world "instead of doubting that we could do anything [was]...ready to believe that we can do everything," the pilot wrote his brother.

The two men never adjusted to fame. When they returned from their flying exhibitions in Europe in 1909, their hometown, Dayton, Ohio, wanted to throw an elaborate parade and party in their honor. Mortified, and intent on getting back to work so Orville could complete his tests for the U.S. military at Fort Myer, the two brothers pleaded, to no avail, with city officials to cancel the event. Ever proper, the Wrights attended, but when asked to speak, Wilbur stepped to the microphone, said, "Thank you, gentlemen," and sat down.

### FIRST WITNESSES

From 1901 to 1903 the skittish brothers allowed only a few people to their campsite, most of them local men who could help them move their gliders and, later, the 600-plus pound *Flyer* around in the sand. The end result: a post office worker, rescue station volunteers, and a curious beekeeper, not scientific colleagues, provided the first detailed public accounts of the Wrights' progress.

**"We couldn't help notice how they held on to each other's hand, sort o' like two folks parting who weren't sure they'd ever see one another again."**

—A volunteer from the nearby U.S. Life Saving Station, who witnessed the brothers talking as Orville prepared for his first flight in the *Flyer* on December 17, 1903

At the time, few lay people understood the difference between flying for miles in an airship and piloting an airplane. The fact that Orville stayed aloft for 12 seconds in front of a handful of men didn't make very good copy. A *Virginian-Pilot* reporter decided to embellish his story.

**"Flying Machine Soars 3 Miles in Teeth of High Wind Over Sand Hills and Waves at Kitty Hawk on Carolina Coast"**

"Steadily it pursued its way, first tacking to port, then to starboard, and then driving straight ahead.

" 'It's a success,' declared Orville Wright to the crowd on the beach after the first mile had been covered.

"But the inventor waited. Not until he had accomplished three miles, putting the machine through all sorts of maneuvers en route, was he satisfied.

"Then he selected a suitable place to land, and gracefully circling drew his invention slowly to earth, where it settled, like some big bird, in the chosen spot.

" 'Eureka,' he cried, as did the alchemists of old."

—*Virginian-Pilot*, December 18, 1903

The *Dayton Evening Herald*, which had run the *Virginian-Pilot's* outlandish version of the Wrights' first flight, published the brothers' correction three weeks later.

**"Only Correct Account of the Two Trials Given to the Public for the First Time by Inventors, Who Denounce Previous Reported Interviews As Fakes"**

"It had not been our intention to make any detailed public statement concerning our private trials of our power 'Flyer' on the 17th of December last; but since the contents of a private telegram... was dishonestly communicated to the newspaper men at the Norfolk office...we feel impelled to make some correction. The real facts were as follows:

"On the morning of Dec. 17, between the hours of 10:30 o'clock and noon, four flights were made, two by Orville Wright and two by Wilbur Wright. The starts were all made from a point on the level sand about a hundred feet west of our camp...

"Into the teeth of a December gale the 'Flyer' made its way forward with a speed of 10 miles an hour over the ground and 30 to 35 miles an hour through the air. It

had previously been decided that for reasons of personal safety these first trials should be made as close to the ground as possible. The height chosen was scarcely sufficient for maneuvering in so gusty a wind, and with no previous acquaintance with the conduct of the machine and its control mechanisms. Consequently the first flight was short."

—*Dayton Evening Herald*, January 6, 1904

In 1904 and 1905, the brothers took the trolley to Huffman Prairie, a field outside Dayton, every day but Sunday to work on their *Flyer*. The locals had their own opinions about what the Wrights were up to.

**"I felt sort of sorry for them. They seemed like well-meaning decent young men. Yet there they were, neglecting their business to waste their time day after day on that ridiculous flying machine. I had an idea they must worry their father."**

—Luther Beard, part-time school teacher, who often saw them on the trolley

How fitting for the publicity-shy Wrights that the most accurate published account by a witness of their flights appeared in an obscure journal called *Gleanings of Bee Culture*. The editor, a beekeeper, wanted to find out for himself if the rumors of the Wrights' flying machine were true. On September 19, 1904, he drove 175 miles from Fairfield to Dayton, Ohio; the next day he walked over to Huffman Prairie and watched as the two brothers went to work.

"When it first turned that circle and came near the starting point, I was right in front of it; and I said then, and I believe still, it was one of the grandest sights, if not the grandest sight, of my life. Imagine a locomotive that has left its track, and it is climbing up in the air right toward you—a locomotive without any wheels, we will say, but with white wings instead.... Well, now imagine that locomotive, with wings that spread 20 feet each way,

**coming right toward you with a tremendous flap of its propellers, and you will have something like what I saw... I tell you friends, the sensation that one feels in such a crisis is something hard to describe."**

—Amos Root, *Gleanings of Bee Culture*, January 1, 1905

### **SKEPTICS**

Afraid that others would steal their technology, the Wright brothers stopped test flights by 1905 and focused instead on securing patents for their control system and contracts with the U.S. and French military. For three years they refused to fly their machines, and their secrecy left them vulnerable to naysayers' lambasting.

**"It seems that [the Wrights'] alleged experiments were made at Dayton, Ohio, and that the newspapers of the United States, alert as they are, allowed these sensational performances to escape their notice. When it is considered that...Langley's experimental model never flew more than a mile, and that Wright's [*sic*] mysterious aeroplane covered a reputed distance of 38 kilometers at the rate of one kilometer a minute, we have the right to exact further information before we place reliance on these French reports. Unfortunately, the Wright brothers are hardly disposed to publish any substantiation or to make public experiments, for reasons best known to themselves."**

—*Scientific American*, January 13, 1905

### **WORLD'S FIRST AIRPLANE PASSENGERS**

Some brave souls had to be the first people to sit as passengers in the fragile-looking *Flyer*. A view from coach:

**"The air was bumpy and I had the feeling that there were moments when Orville didn't have full control of the machine as we dipped groundward. It was as if someone on the ground had a string attached to us and would pull occasionally as they would a kite. But each time Orville would raise the elevator slightly and we would gain back the lost altitude."**

—Benjamin Foulois on flying a test run with Orville at Fort Myer, Virginia, July 30, 1909

### **FANS AND RIVALS**

By the time Wilbur and Orville began regularly staging public flights in the United States, most Americans and Europeans had read about their exploits in the newspapers. But even this more savvy audience found itself transfixed by the sight of an actual airplane buzzing overhead. For many it was tantamount to a religious experience.

**"I've seen him! I've seen him! Yes, I have today seen Wilbur Wright and his great white bird, the beautiful mechanical bird. There is no doubt! Wilbur and Orville Wright have well and truly flown."**

—*Le Figaro*, August 11, 1908

**"The whistles of the passing tugs and ferry boats were tooting a mighty chorus and the Battery sea wall was black with people. The news was flashed over the city, and from the windows of the towering buildings thousands forgot all else and watched the huge artificial bird sailing up the river."**

—*The New York Times*' account of Wilbur Wright's flight up the Hudson River to Grant's Tomb on October 5, 1909

**"I have never seen such a look of wonder on the faces of the multitude. From the gray-haired man to the child, everyone seemed to feel that it was a new day in their lives."**

—A clergyman in Chicago after seeing the Wrights fly at an air meet in 1910

Even the Wrights' most avid critics had to admit that the brothers' flights were infinitely more sophisticated and successful than anything anyone had done in an airplane before. But that didn't keep some competitors and aviation "experts" from chiding the brothers, especially Will, for their arrogant and aloof manner or the peculiar design of their *Flyer*.

**"The Wright machine is astonishing in its simplicity not to say apparent crudity of detail—it is almost a matter of surprise that it holds together. The Voisin machine has at least some pretensions to be considered an engineering job."**

—Aerodynamics expert Frederick Lanchester of England

*In 1910, Dayton held a parade to honor the world-famous local boys (bottom, front row, at left), but the brothers had never sought celebrity, only solutions.*

## THE TWILIGHT YEARS

Both of the brothers loved the process of invention more than the business of capitalizing on their success. Just three years after Wilbur died of typhoid fever in 1912 at the age of 45, Orville quit his job as the president of their airplane manufacturing company. Without his brother Wilbur around to argue with, life just didn't seem as stimulating for Orville, who attended as few public functions as possible.

**"Strange to look at this quiet, mild gray-headed man and to realize that he is the one who flew the plane at Kitty Hawk on the December day."**

—Charles Lindbergh's impression of Orville Wright in 1939, when Orville was 68

## LOOKING BACK

We all have our own personal aviation history: The first time we flew in an airplane or watched a jet leave a trail overhead. Betty Wright Strother, 97, has memories that rise above such standard fare. She was on hand for two of aviation's most significant events. In December 1941, she was living in Pearl Harbor, where her husband was stationed, when the Japanese attacked.

"Some planes came overhead and I was about to call the field and tell them they were being careless with their planes," she says. "But then that first plane bombed the house about three blocks from us."

Thirty-two years earlier, Betty and her parents had been in the crowd that gathered at Fort Myer when Orville Wright (no relation) flew.

**"Whenever something of interest came up, my mother and father got us interested too, so that was the case on us going over there and seeing that plane. We went in a horse and buggy."**

**"The main thing that stuck in my mind at the time was those big dusters—you know, those overcoats—and how as he started to get into the plane he had to wrap it around himself. I remember him getting into the plane and just taking off."**

—Elizabeth Strother, Opelika, Alabama

NEWSPAPERS: DAYTON METRO LIBRARY

# SOARED LIKE AN EAGLE

## Test of Wright Airship a Reported Success.

## OPERATED AGAINST THE WIND



...occurred Near Kitty Hawk, N. C.  
...ine Said to Have Been Under  
...Control—Landing Made at Spot  
...ated—Reached Altitude of Sixty  
...et—Sailed a Distance of Three Miles.



Norfolk, Va., Dec. 18.—It is reported that a successful trial of a flying machine was made yesterday near Kitty Hawk, N. C., by Wilbur and Orville Wright of Dayton, Ohio. It is stated that the machine flew for three miles in a wind blowing at the registered velocity of 15 miles an hour.



# Defining Moments

A FEW FORMAL AND INFORMAL MILESTONES ALONG THE PATH OF AERONAUTICAL PROGRESS  
BY ROGER BILSTEIN



IT WOULD BE FIVE YEARS AFTER THE FIRST FLIGHT BEFORE ORVILLE WRIGHT DEMONSTRATED THE WRIGHT AIRPLANE FOR THE U.S. ARMY AT FORT MYER, VIRGINIA; HIS SWOOPING, CIRCLING 1908 FLIGHT FANNED ALREADY-INTENSE PUBLIC INTEREST. AT ABOUT THE SAME TIME, WILBUR'S DEMONSTRATIONS IN FRANCE WERE DAZZLING EUROPEAN SKEPTICS.

SUDDENLY THE PHENOMENON OF FLIGHT HAD BECOME AN INTERNATIONAL MARVEL, AND THE RUSH TO DEVELOP IT INTRODUCED A RAFT OF ISSUES THAT NEITHER THE WRIGHTS NOR MOST OF THEIR CONTEMPORARIES HAD EVER CONSIDERED: HOW WOULD SKILLED INDIVIDUALS BE TRAINED TO DESIGN AND OVERSEE THE MANUFACTURE OF FINICKY AIRCRAFT? WHO WOULD CONDUCT RESEARCH LEADING TO BETTER STRUCTURAL MATERIALS AND ENGINES? WHAT ABOUT WEATHER FORECASTING? AND AIRPORTS? THE 20TH CENTURY LAY AHEAD, ALONG WITH THE TECHNOLOGIES, PROCESSES, AND INSTITUTIONS THAT MARKED THE ROUTE OF PROGRESS IN AVIATION.



NASA LANGLEY

*Researchers tooled up with wind tunnels like this one at Langley.*

1903

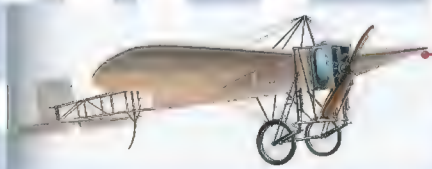
**1903** Dec. 17, Kitty Hawk, NC: Orville Wright makes first controlled, powered flight, piloting the Flyer 120 feet in 12 seconds.

**1906** Oct. 23, Paris: Brazilian Alberto Santos-Dumont makes first substantial public powered flight in Europe in his 14-bis biplane.

1905

**1910** England: Claude Graham-White begins delivering airmail, on an unofficial basis, between Hendon and Windsor.

**1909** July 25, Dover, England: Louis Blériot takes off from Calais, France, in his monoplane and in 37 minutes makes the first aerial crossing of the English Channel.





NASM

World War I broke out in Europe during the summer of 1914, and as the conflict intensified, the superiority of European aviation became so gallingly apparent in the United States that the Smithsonian Institution sent a delegation overseas to assess the situation and make recommendations. The members' report, issued in 1914, helped spur the creation of a National Advisory Committee for Aeronautics a year later. At first, the NACA was merely advisory; it recommended to other federal agencies fruitful research projects they might pursue, but soon it received additional funding and a cluster of buildings at a new U.S. Army airfield in Virginia. The site became the Langley Memorial Aeronautical Laboratory. Formally dedicated in the spring of 1920, the facility soon propelled the United States into the front ranks of nations conducting aeronautical research.

*The first truly modern airliner, Boeing's 247 reigned briefly in the skies over Manhattan until the Douglas DC series made its spectacular entrance.*

### **Eiffel, Guggenheim, & Rohrbach**

In 1913, Jerome Hunsaker began to offer formal instruction at the Massachusetts Institute of Technology in the art and practice of aeronautical engineering. Unable to find suitable textbooks, Hunsaker translated an aerodynamics text that Alexandre Eiffel had written after he designed the Eiffel Tower in Paris and tested aircraft models by dropping them from its heights. The need for trained aero-engineers during World War I stimulated rapid expansion of instruction in the field at the University of Michigan, MIT, and elsewhere.

After the war, the Daniel Guggenheim Fund for the Promotion of Aeronautics underwrote essential programs for weather forecasting, techniques for blind flying, and the expansion of

aeronautical education. Between 1926 and 1930, the fund dispensed over \$3 million, including hundreds of thousands of dollars to various U.S. universities. The Fund's board wanted to encourage aero-training on the West Coast, where fledgling companies like Boeing, Douglas, and Lockheed needed aero-engineers, and it focused on the California Institute of Technology, endowing the Guggenheim Aeronautical Laboratories, which became the GALCIT complex.

The Fund recruited Theodore von Kármán, one of Europe's best young aerodynamicists, to teach and conduct research at GALCIT, where he also became a major figure in shaping policy for both civil and military aviation.

During the 1920s, designers turned to metal construction. Wood, despite

1909

**1910** Mar. 28, Lake Berre, France: Henri Fabre takes off from and lands on water.

**1910** Aug. 27, Long Island, NY: James McCurdy sends air-to-ground radio message from a Curtiss biplane and receives a reply.

**1910** Nov. 14, Hampton Roads, VA: In the first takeoff from a ship, Eugene Ely flies a Curtiss Model D biplane from a specially built wooden platform on the cruiser USS Birmingham.

**1911** Nov. 5, Pasadena, CA: Calbraith Rodgers, in the Wright EX Vin Fiz, completes a 4,321-mile, 49-day cross-country flight from Sheepshead Bay, NY.

**1911** Jan. 15, San Francisco: In an Army test, Lt. Myron Crissy drops a live bomb from an airplane.



NASM (2)

*All-metal construction debuted with the Junkers J.4 (above) and soon came to dominate the industry.*

its economy, availability, and workability, was not strong enough for larger aircraft or the improved cantilever wing structures that had to bear greater loads without the support of struts and wires. All-metal craft built by Junkers in Germany and the Ford Motor Company in the United States were admired for their durability and longevity, but they were too heavy. In Germany, Adolph Rohrbach, an imaginative designer, pursued the concept of stressed-skin construction. In early airplanes, fabrics had served only as a covering, but stressed-metal skin formed a load-bearing part of the airplane's structure. Rohrbach visited the United States in 1927, and his lectures and subsequent articles were followed closely by the U.S. aviation community. At about the same time, the NACA unveiled three areas of new technology: an advanced engine cowl, a catalog of more efficient airfoil shapes, and a number of improvements in streamlining and power plants. The NACA cowl completely enclosed the radial engine's cylinders and gave cooling air a path to follow, thereby reducing drag. A Lockheed Vega equipped with the cowl gained 20 mph. Other developments proved that little things can matter.

### For want of a ring...

One seemingly insignificant item, known as the O-ring, revolutionized retractable landing gear. Early retractable systems relied on the pilot's muscles to retract the gear, but by the 1930s, electric motors and hydraulic cylinders powered retraction as gear increased in size. Most hydraulic systems of the era used leather seals; plagued by persistent leaks, they were unreliable and expensive to maintain. In 1933, Niels Christensen, an independent inventor, devised a seal made of an O-shaped piece of tough, pliable rubber that fit inside a matching groove. This development immediately increased the re-

liability of retractable gear systems and was adopted by military and civil aircraft alike.

Meanwhile, airlines began to pay more attention to consumer complaints, pressuring manufacturers to design cabins that were quieter, heated, and equipped with lavatories. When United Aircraft and Transport placed an order in 1932 for a fast new airliner, Boeing responded with the model 247, a streamlined, low-wing, twin-engine monoplane with retractable gear. Its

*The Douglas DC-3 represented the fruits of millions of dollars spent on research by the NACA and others.*



1913

**1912** Feb. 22, Pau, France: Louis Bechereau's sleek Deperdussin racer, piloted by Jules Védrines, is the first airplane to exceed 100 mph.

**1914** Jan. 1, St. Petersburg, FL: St. Petersburg-Tampa Airboat ferries tourists across Tampa Bay on first scheduled commercial flight.

**1914** June, over the Seine River, France: Lawrence Sperry, in a Curtiss flying boat fitted with four gyroscopes, demonstrates stable flying with no hands on the controls.

1915

**1914** June 30, Russia: In-flight meal served on Igor Sikorsky's four-engine Il'ya Muromets during round-trip flight between St. Petersburg and Kiev.

**1915** Mar. 3: U.S. National Advisory Committee for Aeronautics (NACA) formed as a sponsor of aeronautics research; forerunner of NASA (est. 1958).



LOCKHEED MARTIN

*A voluptuous shape, pressurized cabin, and advanced engines marked Lockheed's Constellation.*

design featured stressed-skin construction. Its engines were powerful new Pratt & Whitney Wasp radials, each housed in a NACA cowl. And it had a heated cabin, seats (each with individual air vents) that featured quality upholstery and mounts to reduce vibration, and a full-service lavatory, complete with mirror (one engineer argued against it on the basis of weight, adding that men didn't need mirrors and women always carried their own).

Boeing showcased its 247 in the Travel and Transport Building at Chicago's 1933 Century of Progress Exposition, where it created a sensation as an icon of 20th century transport technology. Wide-eyed visitors clambered up a catwalk over the wing, past the cockpit, and down again to encounter an actual Wasp engine. But the 247 carried only 10 passengers. Receiving a competing order

from Transcontinental and Western Air, Douglas Aircraft included all of rival Boeing's features plus an improved NACA cowl and better streamlining, bigger engines, and variable-pitch propellers, none of which were available on the first production models of

the 247. The DC-1 looked so promising that Douglas immediately developed a speedier, improved version, the DC-2, which offered 14 seats—nearly half again as many as the 247. In 1934, a DC-2, casually flown by pilots for the Dutch carrier KLM, nearly beat the Comet, a customized deHavilland twin-engine speedster, in the MacRobertson race, from England to Australia. The Douglas design became an international phenomenon and started the company on a stretch of industry dominance that was to last 30 years.

C.R. Smith, impresario of American Airlines, wanted an even bigger, faster version of the DC-2. A fuselage that was enlarged to accommodate railroad-style sleeper berths morphed into

*Wide-eyed visitors clambered up a catwalk over the wing, past the cockpit, and down again to encounter an actual Wasp engine.*

a 21-passenger "dayliner"—the inimitable, indomitable DC-3, which entered service in 1936. With improved engines, twice the passenger capacity of the 247, and an extremely cost-efficient design, the DC-3 flew into aeronautical immortality. Along with its larger, four-engine successors, the DC-3 had wing flaps for added lift during takeoff and landing. By the early 1940s, even larger airliners appeared with pressurized cabins, tricycle landing gear, improved de-icing equipment, autopilot systems, and other technologies that enhanced passenger comfort and safety as well as aircraft reliability and efficiency. By 1943, the Lockheed L-049 Constellation, with its distinctive triple vertical tail, epitomized the era of modern airliners that transformed both wartime air transport and postwar airline transportation.

*In his native Russia, Igor Sikorsky built airliners; in the United States he developed a practical helicopter.*



COURTESY SERGEI SIKORSKY

1917



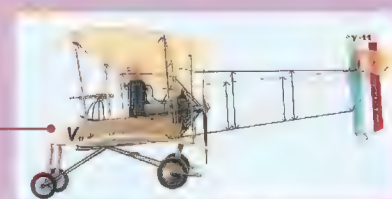
**1916:** Curtiss Company produces JN-4 "Jenny" military trainer, which would become the airplane of choice for barnstormers and mail carriers after the war.



**1918 Apr., Germany:** Fokker D VII, considered by many the best fighter of World War I, enters service.

**In 1914,** Britain, France, and Germany had a total of 436 aircraft in service, which grew to 8,800 by war's end. France's Voisin Type 3 scored the first air-to-air kill.

**1919 May 27, Lisbon, Portugal:** In 19 days, a six-man crew in a Navy-Curtiss flying boat completes the first transatlantic flight, starting from Rockaway, NY.





NASM (2)

*In a flash, military aircraft adopted the turbojet, and propellers were out. Favorites like the North American T-6 trainer were retired.*

### Vertical strides

While enormous strides were being made in fixed-wing design, by the late 1930s Russian émigré Igor Sikorsky had perfected the prototype of the modern helicopter, with a powered rotor overhead to provide both lift and forward thrust and a tail rotor to counteract the main rotor's torque. The helicopter's unique ability to hover and its performance in the Pacific theater of World War II won wider acceptance for the rotorcraft, and this was followed by their dramatic success in evacuating casualties during the Korean War in the 1950s.

During the decades of the 1920s and 1930s, as Sikorsky was fleshing out his ideas, a host of suppliers, vendors, and institutional organizations appeared—forming an infrastructure es-

sential to supporting a growing industry. Traditional manufacturers like Westinghouse, AC Spark Plug, Bendix, Standard Oil, and others moved into the flying game. In the late 1920s, Edwin Link scrounged some bellows, push rods, and linkages from his father's pipe organ company and built a usable flight simulator. At first, only amusement parks showed much interest, but by the late 1930s, the threat of war triggered a surge of military orders. EDO Corporation, named for Earl Dodge Osborn, started to build pontoons for floatplanes in 1925. As a diversified aerospace supplier, EDO continued to flourish in the following years as a fabricator of such military products as under-wing pylons that carry fuel tanks and assorted ordnance. In 1923, Osborn helped launch *Aviation* magazine, and served as its publisher until he sold it to McGraw-Hill in 1929. The periodical eventually became *Aviation Week & Space Technology*, the premier source for aerospace news.

In 1933, a professional society of engineers organized as the Institute for Aeronautical Sciences and later became the American Institute of Aeronautics and Astronautics. Businesses and organizations like these proved invaluable in meeting crucial challenges of World War II.

*Edwin Link's flight simulator made basic flight training cheaper, safer and more accessible.*



1920

**1922** Mar. 20: U.S. Navy commissions its first aircraft carrier, the *USS Langley*.

**1922** Apr. 15: Thomas Midgely of General Motors files patent for leaded gasoline, which leads to high-test aviation fuels.

1922

**1923** June 27: Two U.S. Army de Havilland DH-4Bs conduct first inflight refueling.

**1923** May 3, San Diego: Lt. Oakley Kelly and Lt. John Macready of the U.S. Army Air Service complete nonstop coast-to-coast flight from New York in a Fokker T-2.

## Props hit a wall

But aircraft had hit a speed limit. Propellers were limited at high speeds because when their blades moved at supersonic speeds, they lost thrust. A few mavericks began to consider alternative power plants, including gas turbines. In England, Frank Whittle initiated a dogged research program in the face of nearly universal skepticism—until 1937, when he demonstrated a design that compressed air by spinning it centrifugally. The path of technological evolution in one community can often be plotted in other, equally capable research-and-development groups. Working with no knowledge of Whittle's work, Hans von Ohain, a German, developed a similar engine that powered the first jet airplane, the Heinkel He 178, which flew in 1939. Research in the United States into the

*The shape of things to come: Swept wings and podded engines on this Boeing B-47 define the modern jet.*

new propulsion technology languished despite the fact that a related technology had proved successful: turbo-superchargers.

In April 1941, when U.S. Army Air Forces General Henry "Hap" Arnold paid a visit to England, he was startled to learn of a prototype jet—the Gloster E28/39—then undergoing taxi tests. An irritated Arnold returned home, asking pointed questions about the U.S. aviation community's obvious lack of progress in jet propulsion. In the end, concerned that the technology would fall into German hands, the British furnished U.S. industry with a Whittle engine, blueprints, and eventually a visit by Whittle himself to ex-

*Frank Whittle, in the face of nearly universal skepticism, demonstrated a design that compressed air by spinning it.*

plain how everything worked. General Electric won the contract to construct modified versions of the Whittle jet engine. These early turbojets powered the first U.S. combat jets, such as the Lockheed P-80 Shooting Star and the Grumman F9F Panther. Later in the war, Germany developed the more successful axial-flow jet engine—its compressor used propeller-like vanes to drive the air in a straight path along the axis of the engine. During the course of Operation Paperclip, which the United States mounted at war's end to harvest advanced German research and key

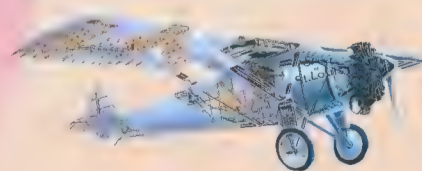
personnel, much of this technology arrived on U.S. shores, where it provided the foundations for similar American designs and became the configuration used in all modern jet engines.

In addition to jet engines, German legacies included significant verification of the viability of swept-back wings. During World War II, high-performance fighters in 500-mph dives began to encounter severe—and sometimes disastrous—aerodynamic buffeting. Wind tunnel tests revealed that shock waves appeared on aircraft surfaces at about Mach 1—the speed of sound. Some aerodynamic adjustments helped—Lockheed gave the P-38 a set of dive flaps to recover the craft from the Mach effect—but fliers also simply had to avoid excessive speeds. In the post-war era, as jet engines led to designs for even faster aircraft, understanding



**1924** Sept. 28, Seattle: Three (of four) Douglas World Cruisers complete circumnavigation of globe following arduous 175-day flight.

1924



**1927** May 21, Paris: Charles Lindbergh lands at Le Bourget 33 hours after leaving Roosevelt Field, Long Island—the first solo, nonstop transatlantic flight.

**1926** May, North Pole: There's still controversy over who flew over the Pole first: Admiral Richard Byrd with pilot Floyd Bennett on May 9, or Umberto Nobile and Roald Amundsen in the dirigible Norge three days later.

**1927** May: Alcoa researcher Edgar Dix introduces Alclad process for fabricating aluminum. Non-corroding airplanes soon take wing.



and coping with what came to be called the “sound barrier” became a paramount challenge. Some aerodynamicists had been thinking about this problem since German researcher Adolph Busemann presented a paper in 1935 at a Rome conference on high-speed flight. Busemann said that when exposed to shock waves trailing from the airplane’s nose at very high speeds, an “arrow” wing would produce less drag than a straight wing. Airplanes of the mid-1930s flew too slowly to encounter sonic buffeting, so his paper received little attention until German aircraft with jet and rocket engines entered service during World War II.

Ironically, the rocket-propelled Bell XS-1, which in 1947 became the first airplane to break the sound barrier, had straight wings. Because its configuration evolved before theories of swept wings had become well known, designers carefully gave the wings a thin cross-section, using thicker wing skins to provide needed load-bearing qualities at supersonic speed. The overall shape of the XS-1, including its rather blunt nose, reflected what was known about the aerodynamic qualities of a .50-caliber bullet; the airplane’s job was to fill in massive gaps of information about the dynamics of aircraft cleaving the air beyond the speed of a gunshot. America’s nimble shift to swept wings relied in part on key contributions from a Russian immigrant and a maverick aerodynamicist at the NACA’s Langley center.

### A man named Jones

At work for Republic Aviation (founded by fellow Russian immigrant Alexan-

*Economics 101: Wide-body jets like this Boeing 747 offered lower seat-mile cost and made fares affordable.*

THE BOEING COMPANY

1927

**1927** June 29, Honolulu: Lt. Albert Hegenberger and Lt. Lester Maitland make first long-range Pacific crossing (from Oakland, CA) in the Atlantic-Fokker C-2 Bird of Paradise, using deduced (“dead”) reckoning.

**1929** May 16: World War I aviation saga Wings, with Clara Bow, wins first Best Picture Oscar.

**1929** Sept. 24, Mitchel Field, NY: Lt. James H. Doolittle takes off in a Consolidated NY-2, reverses direction, then returns to point of departure solely by instrument readings.

1929

**1930** May 15, Chicago: Ellen Church, the first airline stewardess, works a Boeing Air Transport flight from Oakland, CA.

der de Seversky), Michael Gluhareff concluded that a triangular, or delta, wing had great potential at sonic speed. World War II diverted his attention, but a wind tunnel model wound up on the desk of the NACA's Richard Jones. A college dropout, Jones had flown with a barnstorming troupe and eventually wound up in a New Deal-era work program at Langley, where he blossomed into a highly regarded engineer. Examining the Gluhareff model and test documents, Jones realized that recent mathematical formulas and tunnel data sustained the postulates that swept wings are better performers at sonic speeds. When the German work on swept wings came to light during Operation Paperclip, the NACA and the Air Force adroitly exploited the convergence of these lines of investigation. The Boeing B-47 bomber and the North American F-86 fighter, both flown in 1947, acquired swept wings and a configuration that set the pattern for a host of postwar bomber, transport, and fighter designs. The swept-wing North American F-100 Super Sabre, which first flew in 1953, became the first U.S. fighter to crack the sound barrier in level flight. During the 1960s, swept wings and speeds around Mach 2 became the norm.

Military programs like the Convair F-102 interceptor and B-58 supersonic bomber also relied heavily on new-fangled management approaches. Exceedingly complex, such aircraft were designed from scratch with aerodynamic framework, avionics, engines, armament, payload, and maintenance all considered as part of an organic whole—in other words, a weapon system. Systems management required new levels of documentation and bureaucratic expertise. In the cold war era, such aerial weapons usually evolved



in the context of what was considered a national emergency—catching up to or gaining an advantage over the Soviets. It took years for the protracted design-build-test-accept sequence to produce an airplane. “Concurrency” became the watchword, with construction of production facilities, tooling, and other fabrication requirements running in parallel with design and test of the airplane itself.

As high-speed aerodynamics evolved, designers wrestled with problems involving the performance of Mach 2 fighters; aerodynamic forces on ailerons, rudders, and elevators were too great for the pilot. Mechanical and hydraulic systems solved some problems, but they added weight and complexity to airframes and were vulnerable to hostile fire. Moreover, modern aircraft, like sensitive racehorses, had a certain degree of inherent instability; this enhanced their agility in combat and re-

*General aviation aircraft were Bill and Moya Lear's magic carpet.*

duced the size and weight of their control surfaces. To manage control dilemmas, designers sought a solution using computers and electronic systems: “Fly-by-wire” technology replaced me-

chanical cables and linkages to control surfaces with slim electrical cables carrying signals to actuators that moved ailerons, rudders, and elevators. The pilot's joystick was no longer directly connected to the surfaces it controlled—except by electrical impulses. During the 1970s, a series of NASA test programs involving a con-

verted Vought F-8 Crusader supersonic fighter led the way to the first successful fly-by-wire control systems. In the case of the Lockheed F-117A Nighthawk fighter and Northrop's B-2 Spirit bomber, stealth technology dictated designs for completely unstable

*During the 1960s, swept wings and Mach 2 became the norm.*

1931

**1931** Mar. 31, Bazaar, KS: Notre Dame football coach Knute Rockne dies in crash of TWA Fokker F-10A. Public concern over air safety leads to the demise of wood-wing aircraft.

**1934**, Binghamton, NY: U.S. Army Air Corps purchases six Link trainers, also known as the Blue Box, the first flight simulator to train pilots for instrument flying.

**1933** Feb. 8: First flight of Boeing 247, a low-wing, twin-engine, all-metal monoplane that revolutionizes air transport design.

**1933** July 22, Brooklyn, NY: Wiley Post completes seven-day solo global flight in his Lockheed 5C Vega, the Winnie Mae.





RIGHT: NASM; LEFT: THE BOEING COMPANY

Left: Where's the X-45's pilot? On the ground, flying by remote control.



aircraft. Without the computerized fly-by-wire systems, these aircraft would have been unflyable.

A new class of aircraft, unmanned aerial vehicles, or UAVs, completed the evolution by ushering in a total reliance on computers and fly-by-wire technology. The genre began as drones during World War I—like torpedoes with a biplane's wings and tail—and by the time of the Vietnam War, remotely piloted vehicles, or RPVs, had jet engines and carried electronic surveillance gear. The subsequent generation of UAVs included quiet, propeller-driven designs like the General Atomics Predator and jet-powered, long-endurance types like the Northrop Grumman Global Hawk, which operates at high altitudes and carries an impressive array of video cameras and ultra-sensitive electronics. Some UAVs toted missiles, while others took on such challenges as trans-Pacific journeys from the U.S. West Coast to Australia.

For sophisticated, supersonic combat aircraft developed from the late 1950s on, fabrication procedures presented challenges so new that in many such programs, the Air Force had to become a partner with commercial

**The F-100 became the first fighter to feature these one-piece, integrally stiffened skins.**

manufacturers. Aluminum forgings of unprecedented size required Alcoa to adopt innovative methods; Wyman-Gordon, which made machinery to produce specialized components, had to develop new types of presses and machine tools. MIT ran one intensive four-year research program that cost upward of \$180 million to develop numerically controlled machine tools that were directed not by hand but by electronic code and allowed for quicker, more precise manipulation of material. Such

efforts led to a new generation of machine tools delivered by companies like Cincinnati, Kearney and Trecker, Giddings & Lewis, Onsrud, and others. To turn out components from heat-resistant, high-strength metal alloys while reducing the number of stiffeners (the weight problem again) used in constructing wings for supersonic fighters, a whole new process evolved. This revolutionary fabrication method, called electrical discharge machining (EDM), used electrical currents to carve out sections of metal, leaving integral stiffeners. The F-100 became the first fighter to feature these one-piece, integrally stiffened skins.

1934

**1934** Oct. 23, Lake Garda, Italy: Marshall Francesco Agello, flying a Macchi Castoldi MC.72, sets speed record of 440 mph at a Schneider Cup seaplane race, an international competition that pushes the boundaries of aircraft speed. Early contest winners had averaged less than 100 mph.

**1935** Britain: First flight with the Rolls-Royce Merlin V-12 engine, the most important engine used by the Royal Air Force during World War II, powering the Hurricane and the Spitfire, among others.

**1935** Nov. 29, Manila, Philippines: Pan American's Martin M-130 flying boat China Clipper delivers first trans-Pacific airmail following six-day flight from San Francisco. Passenger service to Asia begins 11 months later.

1936

**1935** Dec. 1, Newark, NJ: Airline companies organize and staff first air traffic control center. Federal Bureau of Air Commerce opens a tower in Chicago the following April.



LOCKHEED MARTIN

Three generations of production represented by cloth, metal—and computer. Clockwise from far left: A Thomas-Morse Scout gets its ribs stitched, a Lockheed Hudson gets its rivets, and a Boeing 777 gets its assemblies merged.



THE BOEING COMPANY

Additional unique tooling appeared to fabricate components made of composite materials (derived from plastic, carbon fibers, and other untraditional substances) coupled with metal alloy skins to form a resilient but lightweight “sandwich” panel. The search for lighter components contributed to the creation of an industry for the production of titanium, geared to a previously unheard-of output of up to 600 tons per month. The F-100 used six times as much titanium as early models of the F-86D.

Within the first century of flight, an uninterrupted expansion of technology transformed the structure and performance of the Wrights’ invention. Along the way, an electronic revolution led to

new compact radars and avionics mounted in light airplanes, giant airliners, and Mach-plus fighters. When Boeing developed its 777 airliner in the early 1990s, electronics permeated all aspects of its design, which relied entirely on automation and personal computers and introduced the concept of the “paperless airplane.” Lockheed’s new F-35 Joint Strike Fighter, which incorporates all these aspects of computer electronics, also required a whole new approach to program management in order to accommodate three U.S.

armed services—the Air Force, Navy, and Marines—and the Royal Air Force, all of which will be using the fighter. Moreover, follow-on propulsion systems will be added to the same basic airframe to produce a short-takeoff/vertical-landing variant. (What would the Wright brothers have thought of a STOVL supersonic jet fighter armed with rockets, laser targeting, helmet sight, head-up display, radar, and night combat capability?) Components will be manufactured worldwide and the airplane it-

self will be assembled in the United States and Europe.

And now for the next hundred years...

**MIT ran one intensive four-year program that cost upward of \$180 million to develop numerically controlled machine tools.**



**1935** Dec. 17: Douglas DC-3 introduced, the most popular passenger airplane of its era.

1938

**1937** May 6, Lakehurst, NJ: The Hindenburg catches fire, killing 36 people and ending the era of commercial travel in rigid airships.

**1936** June 26: First flight of a practical helicopter, the German Focke-Achgelis FW-61. (French helicopter builder Paul Cornu had hovered one foot off the ground, for 20 seconds, in 1907.)



**1938**, Lock Haven, PA: First Piper J-3 Cub produced, a name that would become synonymous with light airplanes.



# Wrong

AVIATION'S PATH OF  
PROGRESS HAS NOT BEEN  
A STRAIGHT LINE.

BY GREG GILBERT



Langley's Aerodrome No. 5

NASM

# Turns

**P**LENTY OF BLUNDERS AND BLOOPERS SHOW UP IN THE HISTORY OF THE AIRPLANE. TIME AND AGAIN, INVENTORS (AND INVESTORS) STAKED THEIR HOPES ON DREAMS THAT NEVER QUITE CAME TRUE OR ON IDEAS THAT WENT NOWHERE. AS SOME DESIGNERS CREATED THE CLASSIC AIRCRAFT OF THE PAST CENTURY, OTHERS PROCEEDED THROUGH NUMEROUS WRONG TURNS, AND HERE ARE TEN OF THE MOST MEMORABLE.

## Inherently Stable Aircraft

The first powered aircraft to fly were not built by the Wright brothers. They were large model airplanes constructed by then-Secretary of the Smithsonian Samuel Pierpont Langley, and they flew, propelled by small steam engines, in May 1896. Like models built by hobbyists today, they were inherently stable. With tandem wings canted at a pro-

nounced dihedral and cruciform tails, the “aerodromes,” as Langley called them, were able to fly distances approaching a mile without falling to the side or nosing into the ground. (Langley’s full-scale aerodrome, which dumped his assistant in the Potomac River, was not as successful.)

The *Flyer* that the Wrights experimented with a few years later could nev-

er have flown such distances without the intercession of a pilot. It was an unstable craft equipped with control devices; with them, the pilot could make the biplane climb, descend, and turn.

An early French aeronaut, Henri Farman, followed Langley’s approach. He built a full-scale inherently stable aircraft. In January 1908, he flew it in a complete circle, skidding around corners in wide, level turns by using only a rudder. Later that year, Wilbur Wright, making a demonstration flight at Le Mans, France, warped the wings of his craft to sweep through a series of banked turns, astonishing the audience with his airplane’s precision and agility. Later, a colleague of Farman declared, “Well, we are beaten! We just don’t exist!”

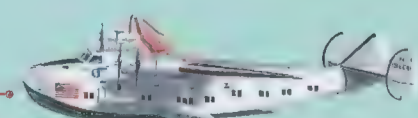
Unstable aircraft, built in the Wright style, flourished into the 1930s, when airplanes grew so large and were capable of flying so far that pilots wea-

**1939** Jan. 27: First flight of Lockheed P-38 fighter, equipped with Allison V-1710 engine, which could function well at high altitudes.

**1939** Apr. 1, Kasumigaura Airfield, Japan: First test flight of the Zero, the carrier-borne Japanese fighter used to attack Pearl Harbor.



**1939** May 20, New York: Pan American’s Boeing B-314 flying boat Yankee Clipper begins transatlantic mail flights to Portugal and France, with passenger flights following a month later.



**1941**  
**1939** Aug. 27, Marieneke, Germany: First flight of a jet aircraft, the Heinkel He 178, with engine designed by Hans von Ohain.

ried of constantly struggling with controls during long flights. At that point, engineers began building some stability back into large bombers and airliners to ease the pilot's workload. Even so, no one returned to inherently stable craft and the flat skidding turns of Langley and Farman.

## Forward-Swept Wings

Reinforcing the notion that the Wrights invented the airplane but the Germans invented everything after that, the first aircraft to fly with forward-swept wings was German: The Ju 287 appeared in August 1944. It had already been discovered that aircraft with wings swept back produced less drag at high speed but were difficult to control at low speeds. (Big surprise: The first aircraft with wings swept back was also German.) Ju 287 designer Hans Wocke reasoned that reversing the sweep should continue to reduce drag at faster speeds but would improve control at lower

Lighter composite materials, which offered both stiffness and strength, provided another opportunity to experiment with forward sweep. They led to the Grumman X-29, an oddly graceful jet with a patriotic paint job. The U.S. Defense Advanced Research Projects Agency commissioned and tested it at NASA's Dryden Flight Test Center in California between 1984 and 1992. The X-29 was extremely unstable and therefore highly maneuverable. Its pilot, relying on a digital flight control system, could maneuver at high angles of attack. Air moving over the forward-swept wings tended to flow inward toward the fuselage rather than outward toward the wing tips; as a result, the wing stalled at the roots before stalling at the tips, and the ailerons near the tips con-



Grumman X-29

speeds. He was right, but his design was slightly ahead of the materials available to build it. The Ju 287 made it through several test flights, but its aluminum wings flexed upward and created concern that they would break off from the airplane.

(Wocke returned to forward-swept wings during the 1960s. He headed an engineering team at the firm Hamburger Flugzeugbau, which created the Hansa business jet, a modest commercial success. The last one flew in 1987.)

tinued to function. So why aren't future fighters showing forward sweep? The X-29 produced too much drag. Designers, including those at the Sukhoi bureau in Russia, have turned to other ways of achieving maneuverability at high angles of attack. Sukhoi's Su-47, which may be fielded to contend with the F-22 Raptor, first flew as the S-37 in the late 1990s with forward-swept wings. Last year, the Russian military elected to continue its development with conventionally swept wings.

## Unducted Fans

Pick any airliner flying today: It's probably powered by turbofan engines. With their gaping intakes and enormous, multi-blade fans, turbofans revolutionized aviation during the late 1960s, propelling aircraft of undreamed-of size: the Lockheed C-5A and Boeing 747. They were able to do so because the great size of the fans—some are as large as 10 feet in diameter—enabled them to move huge quantities of air, increasing the engines' thrust.

The turbofan also offers superb fuel economy. Most of the air pushed rearward by the fan bypasses the engine's combustion chamber and flows at relatively slow speed, increasing the engine's effective thrust without burning additional fuel. But after 1980, when the price of oil had climbed higher than the aircraft it fueled, General Electric sought to develop engines that would push the fanjet's efficiency still further.

Existing versions enclosed the fan within a cylindrical housing, or cowl. The cowl slowed the airflow to prevent the tips of the fan blades from rotating faster than the speed of sound, a condition that would have made the engine unacceptably noisy. Just as supersonic aircraft create sonic booms, fan blades spinning supersonically would cause their own loud disturbances in the air.

The cowl also held thrust reversers, clamshell-like structures that reversed the flow of the jet exhaust, directing it forward so it could be used for braking during landings. Making the fans larger would have also required larger cowls, which would have been heavy and difficult to install and would have needed even heavier thrust-reversers.

GE thus put its hope in an unduct-

NASA DRYDEN

**1940** July 8, Los Angeles: Boeing 307 Stratoliner, with a pressurized cabin that made air travel at high altitude possible, debuts with a 12-hour TWA flight from New York.

**1940** Oct. 25: First flight of P-51 Mustang fighter (prototype), which escorted Allied bombers over Germany.

**1942** Jan. 14, Stratford CT: First flight of the Sikorsky R-4, invented by Russian émigré Igor Sikorsky—the first helicopter to go into production and first used in combat.

1943

1945

**1942** July 19, Germany: Messerschmitt Me 262 Schwalbe, world's first operational jet fighter and the first airplane with a swept-wing design, takes off under jet power. About 300 would see combat, but too late to affect the outcome of the war.

**1942** Oct. 1, Muroc, CA: Robert Stanley pilots first U.S. jet aircraft, the Bell XP-59A Airacomet, with a General Electric engine copied from British jet pioneer Frank Whittle's W.IX design.



ed fan—a fan without a cowl. Its blades were swept back to reduce the drag from supersonic rotation, and, like reversible-pitch propellers of earlier days, the fan blades swiveled to direct thrust forward during landing. The GE 36 UDF engine produced 15,000 pounds of thrust and weighed only three tons.

In NASA-sponsored ground tests, the engine consumed 20 percent less fuel than the standard turbofan, but flight tests showed that the unducted fan was unacceptably noisy, even in versions scaled down in power for the modest-size airliners of the McDonnell Douglas MD-80 series. For larger aircraft, the noise problem would have been far worse. What really killed the unducted fan, however, was the fall in oil prices in the mid-1980s.

## Autogiros

Biplanes flew for decades with great success, but fell by the wayside when they failed to match the speed of monoplanes. The autogiro, a rotary-wing aircraft, suffered a similar fate. A Spanish inventor, Juan de la Cierva, flew the first of them in 1923 and introduced an entirely new mode of flight.

The autogiro was based on the conventional monoplane: It sported stubby fixed wings and a front-mounted engine, but it had a large, unpowered rotor, which turned in the craft's slipstream and yielded additional lift.

An autogiro could fly with a short takeoff run and land nearly vertically, its rotor whirling like a pinwheel as it descended.

Cierva formed a partnership with U.S. airplane builder Harold Pitcairn, who also ran a lucrative airmail route



Pitcairn AC-35 Autogiro: Overtaken by helos

(which he sold to a business that developed it into Eastern Airlines.) Amelia Earhart flew one of the Pitcairn-Cierva craft and praised its safety and ease of control.

But another aircraft was under development in the 1930s that would outshine the autogiro, and by the end of the decade, Igor Sikorsky had mastered its design. A helicopter, which had a powered rotor, could hover, take off and land vertically. Even though the autogiro was faster, the helicopter's eventual success in military operations proved to be so sweeping that the autogiro vanished entirely.

## Custer Channel Wing

There's something valiant, if clown-like, about the Custer Channel Wing. The semi-circular troughs on either side of its fuselage are suggestive of the oversized ears on Disney's car-

Custer Channel Wing



toon elephant, Dumbo. But these channels, through which air was sucked at high speeds by propellers, also created enough lift to bestow on the aircraft Dumbo's amazing capability for short takeoff and landing (STOL). The aircraft could take off in as little as 150 feet.

The Channel Wing was the lifelong obsession of Willard Custer, a distant relative of the general who died fighting the Sioux at Little Big Horn. Custer flew his first version in 1942 and submitted it for military evaluation, but the Army saw no reason to pursue it. Undaunted, Custer sought backers for a civilian aircraft. A 1953 version flew successfully at speeds as low as 22 mph, and actually hovered in an 11-mph wind, but Custer proved a more talented inventor than financial manager. Although his aircraft never went into production, Custer does have a place in aviation history. His first Channel Wing is in the collection of the National Air and Space Museum, and his third can be seen at the Mid Atlantic Air Museum in Reading, Pennsylvania.

## Flying Automobiles

Since *The Man with the Golden Gun's* Scaramanga fled James Bond in a custom fastback-cum-airplane, villains everywhere have patiently awaited a production model. Unfortunately for them, manufacturers have been unable to sustain enthusiasm for the concept.

Convair, a major wartime manufacturer, crafted prototypes of its Convair AirCar in the late 1940s (one was reported to have circled San Diego for over an hour), but the effort ended after one of them crashed and another was lost in a fire.

NASM (2)

1948

**1943** Jan. 13, Germany: First emergency ejection from an aircraft, from the prototype of the Heinkel He 280 V1.

**1943** July 27, Bryan, TX: Acting on a dare, Army flight instructor Maj. Joe Duckworth pilots a single-engine AT-6 trainer into the eye of a hurricane twice on the same day. Scientific "hurricane hunting" flights begin soon after.

**1943** Oct. 3, Cleveland, OH: Trailing their German counterparts, U.S. engineers build the first afterburner for jet engines at the NACA's Lewis Flight Propulsion Laboratory in Ohio.

**1944** Dec. 7, Chicago: Convention on International Civil Aviation establishes principle of a nation's sovereign airspace.

**1945** Mar., Japan: Hundreds of Boeing B-29s, the most ferocious bomber of the war, begin devastating night attacks of Japan's industrial and economic infrastructure.



Two models, Robert Fulton Jr.'s Airphibian and Moulton Taylor's Aerocar, eventually won certification from the Civil Aeronautics Administration, the Federal Aviation Administration's predecessor, but it was the public, not the government, that needed to be convinced. Taylor, dean of the so-called "roadable" airplane, came close to getting his craft into production in 1961, after it had been featured in a popular 1950s TV show starring Bob Cummings. The firm of Ling-Temco-Vought promised to build 1,000 Aerocars if Taylor could persuade 500 enthusiasts to each plunk

down \$1,000. He rounded up little more than

half that number, and the venture died.

Fulton's Airphibian also hit a dead end; after 200,000 miles of driving and 6,000 successful flights, it lost its financial backers. They pulled out of Fulton's company, Continental, Incorporated, and took with them eight production Airphibians meant for CAA inspectors.

Little has been done in the past 40 years to resurrect the always-intriguing concept. The reason: A winged car is too heavy to be a good airplane.

## Convertiplanes

During the heyday of the autogiro in the early '30s, Gerald Herrick invented an aircraft that fused elements found in autogiros with those found in conventional airplanes. The Vertaplane

employed a two-blade rotor: It could be left to spin freely in order to dramatically shorten takeoff rolls, or it could be locked into place before takeoff to form a second wing. Fixed as an additional wing, the rotor effectively converted the aircraft to a biplane, which was faster than an autogiro. Once in flight, the rotor could be unlocked to allow the aircraft to land vertically (the rotor could not be stopped and locked in mid-air).

Initial flight tests were promising, but the aircraft suffered from excessive drag and was too underpowered to

lift more than

a single pilot and a small amount of fuel. When a lack of funding ended further research and develop-

ment, Herrick's aeronautical oddball was put out of its misery.

Convertiplanes reappeared during the 1950s, this time as hybrids trying to combine the speed of fixed-wing aircraft and the vertical capabilities of rotary wings. The McDonnell XV-1 of 1954 took the shape of a helicopter with wings, using a single engine to drive both the rotor and a pusher propeller. It topped speeds of 200 mph, but by 1957, when the Pentagon ended its development, it was clear that helicopters would soon be capable of such speeds. Three companies followed with new designs. The Hiller X-18 mounted en-



McDonnell XV-1

BOEING

gines on a tilting wing; the Curtiss Wright X-19 used tilting rotors. Both were flat failures. The Bell Textron V-22 has been flying for over a decade, but on the question of whether the tilt-rotor is a viable design, the jury's still out.

## Ramjet- and Rocket-Powered Aircraft

Aviation entered World War II with a single practical powerplant, the reciprocating piston engine, and emerged with three new ones: the turbojet, ramjet, and rocket. All three promised speed, but only the fittest would survive.

During World War II, Germany developed a rocket-powered interceptor, the Messerschmitt Me 163. Radar systems of that era lacked the range to give enough warning for propeller-driven airplanes, which took precious time struggling up to the altitudes where bombers flew. The Me 163 was capable of an ultra-quick ascent (it could reach nearly 40,000 feet in

just three and a half minutes),

but it ran out of fuel only minutes after takeoff, had a tough time targeting much slower bombers, and was vulnerable during descent, when it was unpowered. The Luftwaffe chose to place its bets on turbojet Me 262 fighters instead.

In the late 1940s, Republic Aviation designed the awkward-looking XF-91 Thunderceptor for the newly formed U.S. Air Force. It used rockets for an extra boost into combat, but could carry only enough fuel for a 25-minute flight. As did the Luftwaffe before it, the Air Force found solace in the wings of another turbojet—this time the F-104

XAVIER MEAL



Molt Taylor's Aerocar

**1945** Oct. 24, Hurn Airfield, England: An American Overseas Airlines DC-4 flight from New York inaugurates first scheduled landplane passenger service between North America and Europe.

1952

**1947** Oct. 14, Muroc, CA: Capt. Chuck Yeager breaks the "sound barrier" in a Bell X-1.

**1946-47:** U.S. Civil Aeronautics Administration (CAA) introduces VHF omnidirectional radio range (VOR) stations, enabling pilots to stay on course by watching a needle on their instrument panel.

**1946** May 24, Indianapolis: First radar-equipped control tower for civilian aviation demonstrated by CAA.



**1947** Nov. 2, Long Beach, CA: Howard Hughes' Spruce Goose, the largest airplane ever built (wingspan 319 ft. 11 in.), makes its only flight.

**1947** Dec. 30: First flight of Soviet MiG-15, the intimidating Korean War fighter.

**1947** Sept. 18: US Air Force established.

Starfighter. Turbojets triumphed because they used oxygen from the air to burn their fuel; rockets had to carry their own supply of liquid oxidizer—a fundamental disadvantage that could not compensate for the higher speed.

The ramjet had better luck. Invented by Frenchman Rene Lorin in 1913, it dispensed with the turbine's rapidly spinning blades and instead used the force of air rushing in through its carefully shaped intake to compress air for combustion. It could function, therefore, only after being accelerated by another form of propulsion to very high speeds.

In 1948, Stanley Hiller put ramjets at the tips of helicopter rotors for added power, but several problems grounded his prototypes. The ramjets provided only marginal improvement in performance, consumed excessive fuel, and were highly visible at night because of their luminous exhaust. Republic Aviation incorporated the ramjet into another unsuccessful interceptor, the shark-like XF-103, which was designed to fly with both a ramjet and a turbojet, but when the XF-103 was canceled in 1957, the ramjet died with it—at least for piloted aircraft. Several missiles have employed ramjet propulsion systems.

## Supersonic Transports

The Anglo-French Concorde is arguably aviation's most beautiful blunder. How could such a triumph of engineering qualify for a list of wrong turns? It failed in the marketplace. Airlines, other than the state-owned national carriers of the countries that built it, would not buy it because it carried too few passengers and consumed too much fuel. The Concorde was also limited to water routes—its noise and sonic booms made it too annoying to fly over

land—a limitation that further weakened its economic viability. Only 14 entered service.

The Soviet Tu-144 was backed by a government that subsidized fuel and ignored noise, sonic booms, and ozone depletion—three concerns that ended the U.S. effort to build a supersonic transport. The Soviet program survived a horrific crash at the 1973 Paris Air Show and proceeded through an initial production run of 10 aircraft. In 1975, after at least two more crashes, the remaining Tu-144s began a weekly mail route between Moscow and Alma Ata (now part of Kazakhstan). Passenger service began later, in 1977. Operations continued for several years, hobbled by delays and cancellations. More troublesome were problems of high drag and fuel consumption.

Unable to find solutions, Soviet officials grounded the Tu-144 in 1978 and, in an act of desperation, approached managers of the Concorde for help with problems that varied from metal fatigue to engine inlet design. When it became clear that the aircraft lacked the range to cross the Atlantic and thus compete for profitable routes, it lost all propaganda value and was deactivated. With it went the last hopes of a major role for an SST in civil aviation.

## Tail Sitters

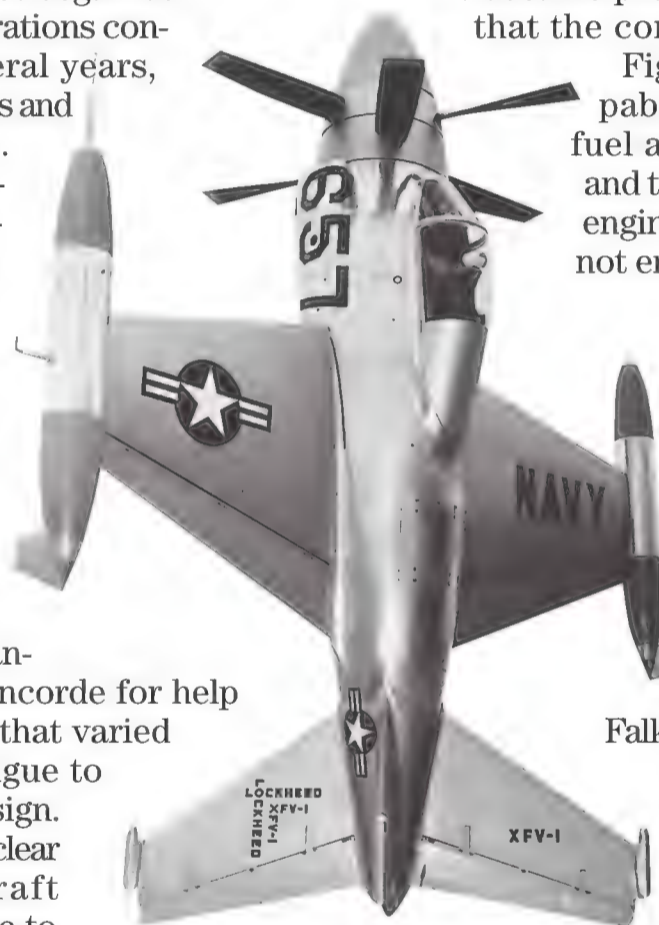
In the years following World War II, the Pentagon pursued three programs to build fighters that, like rockets, could take off vertically: the Ryan X-13 Vertijet, the Lockheed XFV-1, and the Convair XFY-1 Pogo. All three flew during the mid-1950s. The Ryan and Convair craft took off vertically, hovered, and landed on their tails, but were hard to control. Lockheed's entry was never able to take off or land vertically because the engine the Navy provided lacked power for vertical flight.

Unlike other aircraft on this list, the tail sitters had no devoted champions; it became pretty clear pretty fast that the concept was doomed.

Fighters had to be capable of carrying extra fuel and heavy weapons, and the tail sitters' limited engine power was simply not enough.

The military continued to covet craft with the vertical-takeoff-and-landing capability of helicopters and the speed of a fighter jet. The British Harrier fighter fought effectively in the Falklands War of 1982 and served as the first operational fighter of this type. The F-35 Joint Strike Fighter will use downward-deflected thrust from a main-engine-driven lift fan to

take off, hover, and land with a full array of weapons—enough to make a tail sitter keel over with envy.



Lockheed's XFV-1 racked up 23 hours of flight, none of it vertical.

NASM

1955

**1948:** DuPont begins commercial production of titanium, a lightweight metal that will revolutionize aircraft industry.

**1948** July 1, Jamaica, NY: Commercial operations begin at a major new airport built on the site of Idlewild golf course. It was renamed John F. Kennedy Airport in 1963.

**1948** Sept. 18, Edwards, CA: Convair XF-92A is first U.S. jet with a delta wing, a shape that will become standard for supersonic aircraft, from the F-102 to the space shuttle.

1957

**1949** Mar. 2, Ft. Worth, TX: Air Force B-50 Superfortress Lucky Lady II lands after nonstop round-the-world flight aided by aerial refueling, proving ability to deliver nuclear weapons anywhere in the world.

**1949** Sept. 30, Germany: Berlin Airlift ends after delivering 2.3 million tons of food, coal, and supplies over 15 months.

# 10 Great Pilots



PRESENTING THE WORLD'S  
FINEST FLIERS.  
BY PATRICIA TRENNER

W

HEN WE ASSEMBLED THE FOLLOWING LISTS OF GREAT PILOTS (AND THE LIST OF MILESTONE FLIGHTS THAT FOLLOWS ON PAGE 73), WE FACED THE SAME DILEMMA THAT VON HARDESTY, A NATIONAL AIR AND SPACE MUSEUM AERONAUTICS CURATOR, FACED

AS AUTHOR OF *GREAT AVIATORS AND EPIC FLIGHTS* (HUGH LAUTER LEVIN ASSOCIATES, INC., 2003). "IF YOU MENTION JEAN MERMOZ," HARDESTY WRITES IN THE INTRODUCTION, "WHY NOT HENRY GUILLAUMET, WHO CRASHED AND SURVIVED A SIX-DAY ORDEAL IN THE ANDES? IF YOU COVER THE CROSSING OF THE ENGLISH CHANNEL BY LOUIS BLÉRIOT, WHY NOT THE TRANSCONTINENTAL AERIAL TREK OF CAL RODGERS? WHEN THE CHAPTER OUTLINE WAS SHOWN TO ONE CURATOR, HE REMARKED, 'THE PROBLEM IS WHO TO OMIT!' SUCH AN OBSERVATION GENUINELY HAUNTED ALL OF US WHO DESIGNED AND WORKED ON THIS BOOK."

AMEN, WE SAY.

## James H. Doolittle

At age 15, Doolittle built a glider, jumped off a cliff, and crashed. Undaunted, he hauled the pieces home, stuck them back together, and returned to the cliff. After his second plunge, there was nothing left to salvage.

In 1922, Lieutenant Doolittle made a solo crossing of the continental United States in a de Havilland DH-4 in under 24 hours. The Army sent him back to the Massachusetts Institute of Technology, where in 1925 he earned a doctorate in aeronautical engineering. Two years later, he climbed to 10,000 feet in a Curtiss Hawk, pushed the stick forward until he saw red (negative Gs make blood pool in the head), and performed the first outside loop.

In 1929, aided by Paul Kollsman's altimeter and Elmer Sperry's artificial horizon and directional gyro, he flew

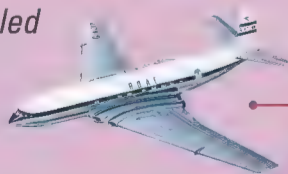
*Jimmy Doolittle had a doctorate in aeronautical engineering.*

1959

**1951:** Annual air passenger-miles (10,679,281,000) exceed traveled Pullman car passenger-miles (10,224,714,000) for the first time.



**1951** Dec., Hampton, VA: In NACA wind tunnels, aerodynamicist Richard Whitcomb verifies "area rule," a key to reducing drag, which hampered supersonic jets. Application of the area rule influenced such designs as the Northrop F-5.



**1962** Apr. 15: First flight of Boeing B-52 Stratofortress bomber, cold war icon and star of the film *Dr. Strangelove*.

**1962** May 2, Johannesburg, South Africa: First passenger jet, Britain's de Havilland Comet, inaugurates service from London. A series of crashes in the early 1950s due to metal fatigue leads to a redesign, and forever tarnishes the Comet's reputation.

**1953** Feb., Los Angeles: Air Force B-29 flies cross-country on autopilot, verifying reliability of MIT researcher Charles Stark Draper's new inertial navigation system.

from takeoff to landing while referring only to instruments. "Aviation has perhaps taken its greatest single step in safety," declared the *New York Times*.

He next took up air racing and collected the major trophies: the Schneider in 1925 with a Curtiss seaplane, the Bendix in 1931 with the Laird Super Solution, and the Thompson in 1932 in one of the treacherous Gee Bees, when he also set the world's landplane speed record. With this triumph, he observed: "I have yet to hear of anyone engaged in this work dying of old age," and retired from racing.

In 1942 Doolittle was sent off to train crews for a mysterious mission. He ended up leading the entire effort. On April 18, 1942, 15 North American B-25s staggered off a carrier and bombed Tokyo. Most ditched off the Chinese coast or crashed; other crew members had bailed out, including Doolittle. Though he was crushed by what he called his "failure," Doolittle was awarded the title Brigadier General and a Congressional Medal of Honor, which, he confided to General Henry "Hap" Arnold, he would spend the rest of his life earning.

2

### Noel Wien

Thanks to Noel Wien, Alaska has a higher ratio of aircraft and pilots to residents than any other state. In the 1920s, almost single-handedly, Wien introduced the airplane to Alaska, and over some 50 years, aircraft became virtually the primary mode of transport in the vast and thinly populated state, which is twice the size of Texas and infinitely less hospitable in climate and geography.

Wien, a native of Minnesota, arrived in Anchorage in June 1924 at age 25

with his first aircraft, an open-cockpit Standard J-1 biplane. Being the only flier in Alaska that summer and the next, and with little competition for a number of years thereafter, just about every flight he made was a first, starting with a flight from Anchorage over the Alaskan Range to Fairbanks. Wien was the first in Alaska and Canada to fly north of the Arctic Circle, and made the first commercial flight between Fairbanks and Nome. He was first to fly the Arctic Coast commercially, the first to fly from North America to Siberia via the Bering Strait, and ultimately the first to fly a year-round service, throughout the vicious winters. All this with sketchy maps, no radio, and virtually no paved landing strips.

Wien got so good, writes author Ira Harkey in *Pioneer Bush Pilot: The Story of Noel Wien*, he could land the Standard in a mere 300 feet. Surveyor Sam O. White said: "I don't believe there was ever anyone around here who could get everything out of an airplane like Noel Wien did. It was like the wings were attached to his own shoulders."

Wien's flights broke other records as well. In 1927 he noted, "the last boat leaving in October didn't mean isolation from the States until the first boat next June. For the first time ever, Nome got mail and fresh foods for Thanksgiving. Everybody looked forward to getting Christmas mail and foods, but they were disappointed—I was down on a lake in a blizzard Christmas Day."

Wien flew everything and everybody to everywhere: bodies to burial sites, tourists to stunning views, gold dust from prospectors to market, sick folks to hospitals, trappers and dogs to hunting grounds. He lost an eye to infection in 1946, but he was able to hold on to his medical certificate and continued flying commercially until 1955. Wien stopped counting flight hours at 11,600.

3

### Robert A. Hoover

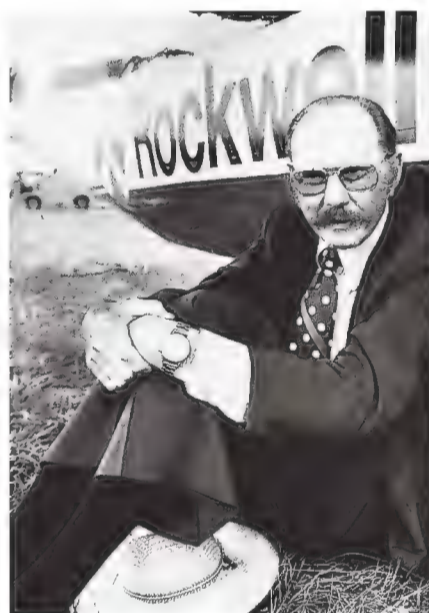
After his Spitfire was shot down by a Focke-Wulf 190 over the Mediterranean in 1944, Hoover was captured and spent 16 months in the Stalag

Luft 1 prison in Barth, Germany. He eventually escaped, appropriated an Fw 190 (which, of course, he had never piloted), and flew to safety in Holland.

After the war Hoover signed up to serve as an Army Air Forces test pilot, flying captured German and Japanese aircraft. He became buddies with Chuck Yeager; Hoover was Yeager's backup pilot in the Bell X-1 program, and he flew chase in a Lockheed P-80 when Yeager first exceeded Mach 1.

Hoover moved on to North American Aviation, where he test-flew the T-28 Trojan,

FJ-2 Fury, AJ-1 Savage, F-86 Sabre, and F-100 Super Sabre, and in the mid-1950s he began flying North American aircraft, both civil and military, at airshows. Jimmy Doolittle called Hoover



Bob Hoover was born to fly airshows.

PATRICIA TRENNER

1962

**1953** May 25, Edwards, CA: Powered by Pratt & Whitney's fuel-efficient J-57 engine, the YF-100A becomes first fighter to reach supersonic speed in level flight.

**1955:** In Atlanta, Delta Air Lines pioneers the hub-and-spoke system for routing flights through a central airport.

**1955** Aug.: First flight of U-2 spy airplane.

**1956** Feb. 17: General Electric's J-79 jet engine propels the F-104 Starfighter to speeds and altitudes previously achieved only by rocket planes.

1964

**1956** June 30, Arizona: Midair collision of TWA Super Constellation and United Air Lines DC-7 over the Grand Canyon kills all 128 passengers and leads to improved air traffic control system and creation of Federal Aviation Administration (FAA).

“the greatest stick-and-rudder man who ever lived.”

Hoover is best known for the “energy management” routine he flew in a Shrike Commander, a twin-engine business aircraft. This fluid demonstration ends with Hoover shutting down both engines and executing a loop and an eight-point hesitation slow roll as he heads back to the runway. He touches down on one tire, then the other, and coasts precisely to the runway center.

Despite the numerous awards accorded him, Hoover remains humble enough to laugh at himself. He notes in his autobiography, *Forever Flying*, that in the 1950s, after showing off his Bugatti racer to the neighborhood kids, he asked, “Well, what do you think?” One youngster’s reply: “I think you’ve got the biggest nose I’ve ever seen.”

4

### Charles A. Lindbergh

The young man who would give aviation its biggest boost since the Wright brothers got his start in aviation as a wing-walker, barnstormer, and parachutist. His proficiency in the latter art paid off when he had to bail out of a trainer during his Army stint and another three times while flying the Chicago-St. Louis mail run for the Robertson Air Corporation.

Any collection of photos of Lind-

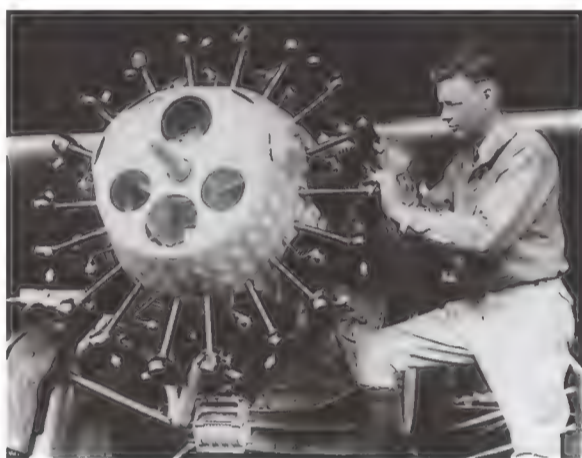
bergh can easily be divided into pre-Atlantic crossing and post-. There are many broad smiles before he flew solo nonstop from New York to Paris in May 1927; not many thereafter. Lindbergh was assaulted by the media and besieged by the adulation of the entire United States. By 1929, when Lindbergh was surveying cross-country routes for Transcontinental Air Transport and posing with movie stars to publicize the airline, the smile had vanished.

Lindbergh made his greatest survey flight in 1931 for Pan Am, when he and

his wife and radio operator/navigator Anne Morrow set out in a Lockheed Sirius on floats to establish the shortest air route from New York to China via Churchill in Canada, Nome, Petropavlosk, Tokyo, and Nanking. Two

years later the pair scoped out north and south Atlantic cities for operational facilities on Pan Am’s transatlantic routes. This round-the-Atlantic flight in the Sirius encompassed landings in Greenland, Iceland, Sweden, Russia, Denmark, Scotland, Portugal, the Canary Islands, Brazil, and Puerto Rico.

In 1944, Lindbergh tested the Vought F4U Corsair in the field—the Solomon Islands in the South Pacific—and flew several missions with the U.S. Marines, downing a Japanese Zero. In New Guinea, he demonstrated to Army Air Forces pilots a fuel-saving technique that extended the range of the Lockheed P-38 from 575 to 750 miles.



*Charles Lindbergh’s flight to Paris was just the beginning of his career.*

His daughter Reeve revealed Lindbergh’s method and his mastery when she recalled flying with him in an Aeronca Champion whose engine had quit: “He was persuading and willing and coaxing that airplane into doing what he wanted it to do, leaning it like a bobsled right down where it could safely land. He could feel its every movement as though it were his own body. My father wasn’t flying the airplane, he was being the airplane. That’s how he had always done it.”

5

### Charles E. Yeager

As a young Army Air Forces pilot in training, Yeager had to overcome airsickness before he went on to down 12 German

fighters, including a Messerschmitt 262, the first jet fighter. After the war, still in the AAF, he trained as a test pilot at Wright Field in Dayton, Ohio, where he got to fly the United States’ first jet fighter, the Bell P-59, which he took on a joyride, flying low over the main street of his West Virginia hometown.

Yeager then went to Muroc Field in California, where Larry Bell introduced him and fellow test pilot Bob Hoover to the Bell XS-1. In his autobiography, *Yeager*, he says that Bell, in assuring them that a deadstick landing would be a piece of cake, bragged that “[W]ithout fuel aboard, she handles like a bird.”

“A live bird or a dead one?” Hoover asked.

In Yeager’s hands, the bullet-shaped XS-1 performed as advertised, and on October 14, 1947, ignoring the pain of two cracked ribs, he reached Mach 1.07 and lived to tell about it.

The X-1 was not designed to take off under its own power; it was air-dropped

1966



**1958** Oct. 26, Paris: Boeing 707, the most celebrated passenger liner of the early Jet Age, enters commercial service with Pan American flight from New York.

**1961** May 1: “Take me to Cuba.” First series of aircraft hijackings in the U.S. begins when a passenger on a flight to Key West, FL, forces pilot to fly to Cuba.

**1961** July 19: *By Love Possessed* is first film shown as part of regular inflight movie service offered by TWA. (Deutsche Luft Hansa was the first airline to show a film in flight, April 6, 1925.)

**1963** Aug. 22: NASA pilot Joe Walker sets unofficial world altitude record of 354,200 feet in the X-15 rocket-powered aircraft.

**1963** Oct. 7: First Learjet (model 23) makes first test flight, inaugurating a brand that would become synonymous with “business jet.”

**1964** Dec. 22, Edwards, CA: First flight of SR-71 Blackbird, the world’s fastest and highest-flying production aircraft.



from a mothership. In January 1949, Yeager fired up the X-1's four rockets on the runway. "There was no ride ever in the world like that one!" he later wrote. The aircraft accelerated so rapidly that when the landing gear was retracted, an actuating rod snapped and the wing flaps blew off.

He also managed to fly the Douglas X-3, Northrop X-4, and Bell X-5, as well as the prototype for the Boeing B-47 swept-wing jet bomber. The Bell X-1A nearly ate him for breakfast one December day in 1953. Yeager thought he could coax the X-1A to Mach 2.3 and bust Scott Crossfield's Mach 2 record, achieved in the Douglas D-558-II Skyrocket. At 80,000 feet and Mach 2.4, the nose yawed, a wing rose, and the X-1A went berserk "in what pilots call going divergent in all three axes," Yeager wrote. "I called it hell." He was able to recover at 25,000 feet.

Yeager was sent to Okinawa in 1954 to test a Soviet MiG-15 that a North Ko-

rean had used to defect. When he stopped test-flying that year, he had logged 10,000 hours in 180 types of military aircraft.

6

## Scott Crossfield

When Navy fighter pilot and flight instructor Scott Crossfield heard about the Bell Experimental Sonic XS-1 under construction in 1947, he wrote to its manufacturer proposing that he be named its first test pilot; he offered to fly it for free. Bell did not reply, but no matter: In 1950 Crossfield was hired by the National Advisory Committee for Aeronautics and sent to Edwards Air Force Base in California to fly the world's hottest X-planes, including the X-1, the tail-less Northrop X-4, the Douglas D-558-I Skystreak and D-558-II Skyrocket, the Convair XF-92A (which he pronounced "under-powered, under-geared, under-braked, and overweight"), and the Bell X-5. He made 100 rocket-plane flights in all. On November 20, 1953, he took the D-558-II to Mach 2.04, becoming the first pilot to fly at twice the speed of sound.

He gained a reputation as a pilot whose first flights were jinxed: On his first X-4 flight, he lost both engines; in the Skyrocket, he flamed out; the windshield iced over in the X-1. After a deadstick landing in a North American F-100, he lost hydraulic pressure and the Su-

per Sabre slammed into a hangar wall. Forever after, Chuck Yeager crowed, "The sonic wall was mine; the hangar wall was Crossfield's."

Despite the many thrills at Edwards in the Golden Age of X-Planes, Crossfield was seduced by an aircraft on the North American drawing board. In 1955, he quit the NACA and signed on with the manufacturer, where he found his calling with the sinister-looking X-15.

Crossfield made the first eight flights of the X-15, learning its idiosyncrasies, and logged another six after NASA and Air Force pilots joined the program. On flight number 4, the fuse-

lage buckled right behind the cockpit on landing, but he had his closest call on the ground, while testing the XLR-99 engine in June 1960. "I put the throttle in the stowed position and pressed the reset switch," Crossfield wrote in his autobiography *Always Another Dawn*. "It was like pushing the plunger on a dynamite detonator. X-15 number three blew up

with incredible force." Fire engines rushed to extinguish the blaze, and Crossfield was extracted from the cockpit. "The only casualty was the crease in my trousers," he told reporters. "The firemen got them wet when they sprayed the airplane with water." You sure it was the firemen? a reporter asked. Yes, he was sure, he said. "I pictured the headline: 'Space Ship Explodes; Pilot Wets Pants.'"



Scott Crossfield made 100 rocket-plane flights.

NASA DRYDEN



NASM

Chuck Yeager was the star of Tom Wolfe's book *The Right Stuff*.

1969

**1967** Mar. 1: FAA begins requiring Cockpit Voice Recorders in large passenger aircraft. In September the agency publishes new air cabin safety rules, dictating everything from number of exits to stowing of carry-on baggage.

**1968** July 19: After a wave of hijackings, FAA announces that "sky marshals" have begun flying on Florida-bound flights.

**1968** Dec. 31: Soviet Tupolev Tu-144 is first supersonic airliner to fly, beating the European Concorde by two months.

1971

**1969** Feb. 9: Boeing 747 jumbo jet, with a capacity of 452 passengers, makes its first flight.



7

### Erich Hartmann

Unlike the rest of the pilots in “Ten Great,” Erich Hartmann flew only one aircraft type, and did almost all his flying during World War II. But his downing a mind-boggling 352 enemy aircraft and earning the title of the Greatest Ace of All Time, No Kidding, places him on this list fair and square.

Hartmann’s mother taught him to fly gliders in his teens. He enlisted in the Luftwaffe in 1940, and his proficiency at gunnery school marked him as a rising star. When he arrived on the Eastern Front at age 20, he was nicknamed *Bubi* (boy) by fellow pilots, and took to the Messerschmitt Me 109 like a duck to water.

Hartmann’s winning technique was to fly so close to the enemy that he couldn’t miss. In November 1942 he scored his first victory, and within a year had downed 148 aircraft. The number of medals and awards seemed to keep pace with the number of fallen aircraft, which reached 301 in August 1944.

His superiors deemed him too valuable an asset to remain in combat (he was forced down 16 times) and called him back to test the Messerschmitt Me 262. But Hartmann was dedicated to fighting the Soviets and finagled a reassignment to the front. He was made a group commander and downed another 51 aircraft before Germany surrendered. In less than

three years, he had flown 825 combat sorties.

Hartmann spent 10 years in a Russian prison. Three years after his release in 1955, he was commanding West Germany’s first all-jet fighter wing. He remained with the air force for another 15 years.

8

### Anthony W. LeVier

Along with the P-38, the U-2, and the SR-71, Tony LeVier was one of Lockheed’s most prized legends. LeVier cut his teeth on air racing and placed second in the 1939 Thompson Trophy Race. The next year he was hired as a test pilot by General Motors; then he moved to Lockheed.

LeVier flight-tested the P-38 Lightning to the ragged edges of its envelope and was sent to England to teach

Eighth Air Force pilots how to get the most out of it. On one harrowing flight, in a 60-degree dive at over 500 mph initiated at 35,000 feet, the airplane started to nose over; LeVier hauled back on the stick, trying to maintain dive angle. What saved him were dive-recovery flaps that engineers had just installed to prevent this very problem. At 13,000 feet, LeVier slowly regained control. “My strain gauges were set

for 100 percent of limit load,” he reported in *Test Pilots* by Richard Hallion, “and they were all over 100 and all the red warning lights were on when



LOCKHEED MARTIN

*Tony LeVier flew Lockheed’s greatest legends.*

I finally got out of the dive.”

Next up: the XP-80A, the nation’s first operational jet fighter. In 1945, by which time he was Lockheed’s chief test pilot, an XP-80’s turbine disintegrated and took the tail off the airplane. LeVier bailed out and crushed two vertebrae upon landing, an injury that grounded him for six months. He later called it “the most horrifying experience of my whole flying career.”

After World War II ended, LeVier worked with the model 75 Saturn and XR60-1 Constitution transports, and on the side bought a P-38 and got back into air racing. In 1946 he again placed second in the Thompson race.

LeVier was the first to fly the XF-90, the YF-94 Starfire, the XF-104 Starfighter, and the U-2. (In *Kelly: More Than My Share of It All*, Lockheed designer Kelly Johnson recounts that when LeVier first saw the F-104, he asked, “Where are the wings?”—a question a great many others at least wondered about.) In 1950 he piloted the first Lockheed aircraft to surpass Mach 1, an F-90, which he dove at an angle of 60 degrees to reach 900 mph. When LeVier retired in 1974, he had made the first flights of 20 aircraft, had flown some 240 types of aircraft, and had survived eight crashes and a mid-air collision.

9

### Jean Mermoz

In January 1921, on his third try, Jean Mermoz got his pilot’s license. Three years later, he signed up as a pilot with

Lignes Aeriennes Latécoère, and set out to attain the goal of aircraft designer Pierre Latécoère: to create an airmail line linking Europe with Africa and South America.

In 1926, Mermoz had engine trouble

1973

**1969** Dec.: The FAA certifies the first airplane made entirely of composite materials, the Windecker Eagle AC-7.

**1970** June: Gallup poll finds that about half (47 percent) of American adults have flown on a scheduled airline.

**1971** Nov. 24: D.B. Cooper disappears in Washington state after parachuting from a Boeing 727 passenger liner with \$200,000 in extortion money. Still history’s only unsolved hijacking.

**1972** May 25, Edwards, CA: NASA F-8 research flight demonstrates a computerized, “fly by wire” flight control system. First put in service in the F-16 fighter, it is widely used today by aircraft ranging from airliners to the space shuttle.

over the Mauritanian desert and made an emergency landing. He was captured by nomadic Moors and held prisoner until a ransom was paid—a common practice and one of the many torments on the Latécoère airmail routes, which linked Toulouse to Barcelona, Casablanca, and Dakar. Mermoz was lucky—five Latécoère pilots were killed by Moors. Other hazards: the hostile Sahara, impenetrable Andes, and 150-mph winds that roiled over the southern Argentine coast.

In 1927, Lignes Aériennes Latécoère became Compagnie Général Aéropostale, and Mermoz took charge of the South American routes. He made Aéropostale's first South American night flight in April 1928 from Natal in Brazil to Buenos Aires in Argentina, along a route unmarked by any sort of beacon. After he showed the way, mail delivery was no longer restricted to daylight-only operations.

Mermoz next tackled shortening the Argentina-to-Chile route; pilots had to make a thousand-mile detour to get around the Andes. With mechanic Alexandre Collenot, Mermoz set out in a Latécoère 25 monoplane and found an updraft that carried them through a mountain pass, but a downdraft smashed the aircraft onto a plateau at 12,000 feet. After determining that they could not hike out, Mermoz cleared a crude path to the edge of the precipice and removed from the aircraft anything that wasn't bolted down. He and Collenot strapped themselves in, and Mermoz got the airplane rolling down the path. In effect, they dove off the mountain, and Mermoz pointed the nose straight down, hoping to gain flying speed. Again, luck was with him. And in July 1929, with the acquisition of Potez 25 open-cockpit biplanes that had a much higher ceiling than the Laté

25, Mermoz and Henry Guillaumet opened a scheduled route between Buenos Aires and Santiago.

In early 1930, Aéropostale looked to bridge the Atlantic. Mermoz, in a new Latécoère 28 float-equipped monoplane, took off on May 12 from St. Louis, Senegal, with a navigator, a radio operator, and a load of mail. As night fell, they flew into a series of waterspouts that rose into stormy clouds. In *Wind, Sand and Stars*, published in 1940, fellow Aéropostale pilot Antoine de Saint-Exupéry wrote: "Through these uninhabited ruins Mermoz made his way, gliding slantwise from one channel of light to the next, flying for four hours through these corridors of moonlight. And this spectacle was so overwhelming that only after he had got through the Black Hole did Mermoz awaken to the fact that he had not been afraid...."

Mermoz flew 1,900 miles in 19.5 hours, and landed in the Natal harbor the next morning. "Pioneering thus, Mermoz had cleared the desert, the mountains, the night, and the sea," Saint-Exupéry wrote. "He had been forced down more than once.... And each time that he got safely home, it was but to start out again."

The U.S. press called Mermoz "France's Lindbergh." On December 7, 1936, Mermoz departed Africa in a four-engine seaplane, bound for Brazil, on the weekly mail run. It was his 28th Atlantic crossing. Neither he nor his crew were seen again.

10

## Jacqueline Auriol

The daughter-in-law of Vincent Auriol, president of France from 1947 to 1954, Jacqueline Auriol learned to fly so she could escape the stuffy

protocol of the Palais Elysée. Her mentor, instructor Raymond Guillaume, imbued her with a passion for aerobatics. After the crash of a Scan 30 amphibian in which she was a passenger, she faced 22 surgeries to put her face back together; yet, her first words in the ambulance rushing her to the hospital were "Will it be long before I can fly again?"

When Auriol recovered, she earned a helicopter rating, and in 1950, she became the first woman pilot admitted to France's military Flight Test Centre.

In 1951, Auriol and U.S. pilot Jacqueline Cochran began swapping speed records: Auriol broke Cochran's record, set in a P-51 Mustang, by flying a Vampire jet at 508 mph. She set a new record

in 1952 in a Sud-Est Mistral, again in 1953 in a Dassault Mystère IV, and in 1955 she reclaimed the record from Cochran in a Mystère IV N. For the last three of these flights, she was awarded the Harmon Trophy for the greatest aeronautical feat of the year—in 1952, at Cochran's request. In 1962, Auriol reclaimed the record from Cochran in a Dassault Mirage IIIC; Cochran promptly

took it back with a Lockheed TF-104G. The following year, Auriol topped her in a Mirage IIIR at 1,266 mph.



Jacqueline Auriol had a need for speed.

1976

**1973 Jan. 5:** FAA anti-hijacking regulation takes effect, requiring all U.S. carriers to inspect carry-on baggage and scan passengers with metal detectors.

**1977 Sept. 26:** Laker Airways pioneers cut-rate air fares with its Skytrain service from London to New York.

**1978 Oct. 24:** President Jimmy Carter signs the Airline Deregulation Act of 1978, leading to dramatic fare reductions and a still-ongoing shakeup in the airline business.

1978

**1979 June 12:** Cyclist Bryan Allen pilots a human-powered vehicle, the 70-pound Gossamer Albatross, across the English Channel.

# 10 Milestone Flights

THE FLIGHTS THAT SHOWED  
THE WORLD ALL THE PLACES  
AVIATION COULD REACH.

BY PERRY TURNER

**1**

## First powered flight in public

Fearing the attention of possible competitors, the Wrights tried to keep their achievement of powered flight secret for five years while they developed their *Flyers* further. Meanwhile, in France, Brazilian inventor Alberto Santos-Dumont was feeling no such inhibitions. Santos-Dumont designed *14-bis*, a pine-frame biplane with a 24-horsepower Antoinette motorboat engine, and he made several flights in it before crowds outside Paris. Technically, his first flight was on September 13, 1906, but it went only about 23 feet and reached an altitude—if that is the word—of two feet. The flight he made on October 23, which covered 197 feet at an altitude of about 10 feet, was his first substantial flight. It was also the first powered flight made anywhere outside of the United States, as well as the first powered flight by a non-Wright airplane.



NASM

A few portions of the Paris newspaper *Le Figaro*'s account: "[S]uddenly, Santos-Dumont points the end of the machine skyward, and the wheels visibly, unambiguously, leave the soil: the aeroplane flies. The whole crowd is stirred. Santos-Dumont seems to fly like some immense bird in a fairy tale....

*Befitting a Paris audience, Alberto Santos-Dumont cut a dandy figure in the pilot basket of his 14-bis.*

Attempting to prolong the flight, he makes an adjustment to the nose of the craft, but—alas—in too brusque a movement! The aeroplane sinks."

1980

**1981** Apr., Newark, NJ: People Express begins cheap passenger service, becomes the fifth largest airline by 1986, then files for bankruptcy later that year.

**1981** June 18, Nevada: First flight of F-117A stealth fighter.



2

### First carrier landing

A pilot for the Curtiss Aviation Company, Eugene Ely made the first landing of an airplane on the deck of a ship. The “carrier” used in the demonstration was the USS *Pennsylvania*, a battleship stationed in San Francisco Bay. The demonstration team had equipped the ship’s fantail with a wooden landing platform. Ely’s Curtiss model D pusher, the *Albany Flyer*, had no brakes; to halt it after landing, the team had equipped it with hooks that were to catch on one or more of 22 ropes that had been stretched across the landing platform and secured with sandbags.

On January 18, 1911, Ely took off from San Francisco’s Tanforan Field. He flew out over the bay, turned, and descended toward the *Pennsylvania*.

On his first attempts, Ely was unable to land, but on the third, flying at about 40 mph, he accomplished what all naval aviators have had to master



Naval aviation’s first arresting gear: ropes anchored by sandbags.

since: He flew his airplane low enough to get his hooks to catch. His caught on the last ropes. “This is the most important landing since the dove returned to the ark,” the captain of the *Pennsylvania* declared.

4

### First aerial refueling

The trouble with airplanes is they have to come down, and not always when it’s convenient for the air crew. In 1923, under the command of Major Henry H. “Hap” Arnold, then commander of Rockwell Field in San Diego, the Army initiated a test program to determine whether it was possible to keep an airplane in the air by refueling as it flew.

On a June 27 flight over Rockwell Field, one de Havilland DH-4B, flown by Lieutenants Virgil Hines and Frank Seifert, dropped a 50-foot rubber hose down to a recipient DH-4, flown by Army Air Service Lieutenant Lowell H. Smith. In the rear seat of the second craft, crew member John Richter grabbed the hose with his hands, connected it to the fuel tank in his DH-4, and opened a valve in the hose. Air-to-air refueling was born. The technique enabled the receiving craft to keep flying over Rockwell for six and a half hours (and, incidentally, to set a distance record—3,293 miles).

3

### First armed air-to-air kill

World War I provided the first opportunity for one airplane to down another. On October 5, 1914, French pilot Joseph Frantz and mechanic/observer Louis Quénault were returning from a mission in a Voisin III biplane bomber. Their aircraft had just been outfitted with a Hotchkiss machine gun, and Quénault, sitting in front, had been instructed to try it out. At 6,500 feet over the French village of Jamoigne, he got his chance. A German Aviatik B.1, flown by Sergeant Wilhelm Schlichting, had



A Voisin bomber was transformed into the world’s original fighter.

been flying reconnaissance over French positions when Quénault spotted it below. He opened fire, and soon the Aviatik plummeted to earth. French troops watching from the ground burst into applause.

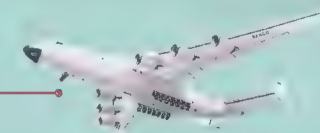
1983

**1986:** Executive Jets pioneers the concept of business jet time-sharing with its NetJets program.

1985

**1986** Dec. 23, Edwards, CA: Jeana Yeager and Dick Rutan land the homebuilt Voyager after completing the first nonstop unrefueled flight around the world.

**1988** Dec. 21: First flight of Antonov An-225 Mriya transport, at 1.3 million pounds the heaviest aircraft ever built.



5

## First transatlantic air crossing

Having made the first solo, nonstop transatlantic flight, Charles Lindbergh became the romantic favorite for the loneliness-of-the-long-distance-flier archetype. But aircraft had first crossed the Atlantic years earlier, and in a decidedly less lyrical team effort. During World War I, the U.S. Navy had commissioned Glenn Curtiss to build flying boats with enough range to guard U.S. ships in the Atlantic against German submarines. Curtiss built four, NC-1 through NC-4 ("NC" stood for "Navy-Curtiss"), but the war ended before the craft could enter service.

Eventually, the Navy decided to en-

ter the NCs in a competition sponsored by newspaper publisher Alfred Harmsworth, a.k.a. Lord Northcliffe. The award: \$10,000 for the first aircraft to cross the Atlantic Ocean.

On May 8, 1919, NC-1, NC-3, and NC-4, each with six crew members, took off from Rockaway Naval Air Station on Long Island, bound for Halifax, Nova Scotia. (NC-2 had been damaged and was grounded; it served as a source for spare parts for the other "Nancies," as the Navy called the NCs.) On May 16, the three craft left Canada for the long, gray haul over the Atlantic. To help the effort, the Navy stationed ships across the ocean to serve as navigation aids.

As the NCs approached the Azores,

islands located 600 miles from Portugal, the weather turned miserable—rainy and foggy. The crews of the NC-1 and NC-3 landed their craft on the sea to await clearer weather, but they sustained damage and were unable to take off. The NC-1 crew was picked up by a Greek steamer. NC-3 drifted over 200 miles before it got to the Azores.

NC-4 had better luck. On May 27, it finally landed in the Tagus River of Lisbon, Portugal. "We are safely on the other side of the pond," Lieutenant Commander Albert Read radioed, a tad prosaically. "The job is finished."

*In foul weather, the NC-4's pilot almost put the flying boat into a spin, but he finally made it to Lisbon.*



NASM

1987

**1993** Dec. 8: Global Positioning System (GPS) network goes into operation, initially with 24 satellites, revolutionizing global navigation.

**1997** Feb. 5, Arlington, TX: First test flight of the half-helicopter, half-airplane V-22 Osprey.

**1994** July 3: First flight of Predator Unmanned Aerial Vehicle (UAV). Era of pilotless military aviation begins with reconnaissance flights over Bosnia a year later.

# 6

## First flight on instruments

On the morning of September 24, 1929, at Mitchel Field in Long Island, New York, Army Air Corps Lieutenant James H. Doolittle set about the task of blinding himself. He sat under a canvas canopy that had been installed in the rear cockpit of a Consolidated NY2 Husky. His only source of illumination: an instrument on the control panel that gave off green light. Doolittle was preparing to make the world's first flight without any recourse to the view through his windscreen. He would depend entirely on instruments—the turn-and-bank indicator, airspeed indicator, artificial horizon, directional gyro, barometric altimeter, and short-range landing beam system, plus a stopwatch.

Doolittle had wanted to make the blind flight alone, but the organization sponsoring the project, the Daniel Guggenheim Fund for the Promotion of Aeronautics, insisted that a second pilot, Lieutenant Ben Kelsey, be in the open front cockpit, which had a duplicate set of controls, in case it was necessary to avert a mid-air collision, a theoretical danger on an instrument-only flight.

Doolittle took off. The flight extended 15 miles, during which he executed two 180-degree turns. In the landing, he used a short-range radio beacon system to home in on the runway, and the artificial horizon to keep his craft level. Copilot Kelsey never once had to use his duplicate controls. All in all, the flight was as uneventful as it was historic.



# 7

## First jet flight

The first flight in a jet aircraft was made on August 27, 1939, by a German, Erich Warsitz. His airplane, a Heinkel He 178, was powered by an 838-pound-static-thrust Heinkel HeS38 turbojet engine, designed by Hans von Ohain. Wary of the engine, Warsitz carried a hammer to use in case he had to escape the cockpit.

He took off from the Heinkel Airfield in Marieneke, Germany, reached a speed of more than 400 mph, remained airborne for seven minutes, then landed. The engine's only misbehavior: On takeoff, it sucked in a bird.

# 8

## First Inflight Hijacking

Not all milestone flights are records to take pride in. The first inflight hijacking took place on July 16, 1948, when four Chinese passengers demanded control of a Cathay Pacific Consolidated Catalina OA-10 seaplane en route from Macao to Hong Kong. When the pilot refused to give in, the hijackers shot and killed him and his copilot. The pilot's body fell on the control stick, putting the Catalina, *Miss Macao*, into a dive. The aircraft smashed into the sea off Macao, and 25 of the 26 people aboard were killed. The sole survivor was the hijackers' leader.



*James Doolittle helped aviation conquer a deadly complication—fog—when he showed that pilots could rely completely on their instruments.*

1990

**1998 Feb. 28, Edwards, CA:** First flight of the high-flying Global Hawk UAV reconnaissance aircraft.

1992

**2000 Dec. 17:** Airbus begins production of A380 "superjumbo" passenger jet, capable of seating an unprecedented 840 passengers.



1994

**2001 July 20, Edwards, CA:** Lockheed Martin X-35B takes off vertically, flies a supersonic "dash," then lands vertically.



*The first jet aircraft to fly, the Heinkel He 178 was powered by a turbojet engine developed in Germany. But the technology had been pioneered independently by Frank Whittle in England.*

9

### First flight to break the sound barrier

No, it isn't really a "barrier," but something seemed to break on October 16, 1947, when U.S.

Air Force test pilot Chuck Yeager became the first person to fly faster than the speed of sound. He was flying a rocket-powered Bell X-1 over Muroc Dry Lake in California when he passed Mach 1, "and in that moment," reported Tom Wolfe in *The Right Stuff*, "on the ground, they heard a boom rock over the desert floor—just as the physicist Theodore von Kármán had predicted many years before."

At that point, Yeager had reached an altitude of about 43,000 feet. The atmosphere was so thin it held almost no light-reflecting dust. "The sky turned a deep purple," wrote Wolfe, "and all at once the stars and moon came out—and the sun shone at the same time.... [Yeager] was simply looking out into space." The X-1's foray beyond Mach 1 lasted a little more than 20 seconds. The fame Yeager earned for the flight: 55 years and still going strong.

10


### First helicopter hoist rescue

Texaco oil barge 397 was in trouble. It was November 28, 1945, and the barge, with two men on board, had broken away from a tanker off Bridgeport Harbor, Connecticut, and was drifting away. After a few hours, the barge washed up on Penfield Reef, off the town of Fairfield.

The men on the barge, Joseph Pawlik and Steven Penninger, set off flares. Spotting them, a group of townspeople gathered on a nearby beach to watch the hapless barge as it was battered by agitated waves. One person in the crowd had an idea: Sikorsky Aircraft was in nearby Bridgeport; perhaps a helicopter from there could be recruited to help. Someone put in a call to the plant.

Sikorsky test pilot (and Igor Sikorsky's cousin) Jimmy Viner and a friend, Jackson E. Beighle, climbed into a helicopter and quickly flew to the barge. When the pilots saw the problem, they returned to the plant and got into an R-5 that had been recently equipped with a hoist.

Once back over the barge, they dropped a note to the stranded men, telling them a harness was about to be dropped. Penninger donned the harness and was hoisted up quickly, but because the R-5's cabin was so small, he had to be flown back while hanging half out of the craft, clinging to Beighle. Pawlik had an even worse time: As he was being lifted, the hoist stalled, so he had to be flown while hanging 30 feet below the helicopter, battered by high winds.

At the beach, a news photographer got a gripping shot of Pawlik dangling; the next day, it appeared in newspapers all over the country. From that day on, the helicopter enjoyed a reputation as the Good Samaritan of aircraft. 



*As Chuck Yeager passed Mach 1, his X-1 left a wake of "shock diamonds"—a pattern of air compression forming in the aircraft's exhaust.*

1996

**2001** Aug. 13, Hawaii: Remotely piloted Helios flying wing sets altitude record (96,863 feet) for propeller-driven airplane.

1998

**2002** March 27, Edwards CA: NASA F/A-18 begins testing Active Aeroelastic Wing (AAW) technology for flight control, a 21st century twist on the wing warping technique pioneered by the Wright brothers.

2000

# Aviation's Birth Certificate

FROM A NEWLY UNVEILED  
COLLECTION: INSIGHTS INTO  
THE WRIGHT COMPANY.

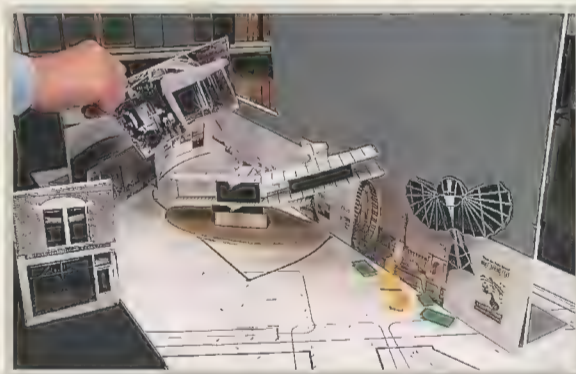
BY DOUGLAS GANTENBEIN PHOTOGRAPHS BY PHIL SCHOFIELD

**D**ENNIS PARKS, SENIOR CURATOR AT THE MUSEUM OF FLIGHT IN SEATTLE, RUNS HIS FINGERS ALONG THE EDGES OF FADED, YELLOW, LEATHER-BOUND PAPERS. "THIS COMPANY SHALL BE CALLED THE WRIGHT COMPANY," READS THE FIRST SHEET.

"The purposes for which it is to be formed are...to manufacture, sell, deal in, operate or otherwise use at any places on the North American continent, and the islands adjacent to them, machines, ships and other mechanical contrivances for aerial operation." Seven pages later in bold handwriting are two signatures: Wilbur Wright and Orville Wright.

"This," says Parks, "is the beginning of an industry."

These 1909 Wright Company incorporation records are among hundreds of early-aviation documents acquired by the museum last March from a collector in Florida. While certainly of great importance to researchers and historians, the papers also proffer a compelling personal story: one of struggle, brief triumphs, and difficult decisions made by the Wrights and other company officials feeling their way through a brand-new endeavor. "They had this new thing called an airplane," says Parks, "but they were trying to figure out what the heck to do with it and how to make money with it."



*Paper, airplanes: The Museum of Flight's scale model of an exhibit that will show off its new treasure.*

attended by such captains of industry as Cornelius Vanderbilt, and more than 900 letters chronicling the company's efforts to establish itself. With the acquisition, the Museum of Flight has become one of the country's three most important repositories of Wright documents, matching in importance the Library of Congress, which contains

The collection contains nearly complete records of the company's six years in existence—ledgers, minutes from board meetings

correspondences between the Wrights and famous aviation pioneers, such as Octave Chanute, and Wright State University in Dayton, Ohio, hometown of the bicycle-mechanics-turned-airplane-inventors, where many Wright family records are held.

"It was the last great collection of materials related to the Wright Company outside a major library," says Tom Crouch, a curator at the National Air and Space Museum and a biographer of the Wrights. "To have it available now at the Museum of Flight is really a wonderful thing."

The papers show the tenuousness of the Wrights' business. A letter from company secretary Alpheus Barnes bemoaning the poor take at a 1910 flying exhibition is typical. "The receipts of our first Meet are certainly rather disappointing," he writes. "There is nothing left for us to do but put the money in the bank with best grace possible." In a 1914 letter, Barnes frets over the lack of sales: "As we have had no inquiries for months, it is certain that we must advertise and let the public know we are ready to make delivery, and the reduced price, etc." Another letter sharply questions the Illinois State Board of Agriculture about proceeds not yet received from a state fair refreshment tent—the Wrights had had an airplane there, had been promised 25 percent of the "tent receipts," and had been told by their pilot that the tent had taken in \$1,983.

Still, there were successes too: royalties from patents, ticket sales for flying exhibitions (\$20,000 on one occasion in Asbury Park, New Jersey), sales of aircraft to individuals, and aircraft contracts with the U.S. Army and Navy. Those rewards are coupled with an almost touching naïveté—or is it flim-flam? In a 1910 letter to J. Fletcher Cobb of Oroville, California—a potential customer—Barnes offers these encouraging words: "We...believe that anyone can learn to fly successfully within a very short time—say a week."

Perhaps. But the experiences of even the best trained Wright pilots indicate that flying the Wright machines was anything but easy. A letter discussing pay for pilot Archibald Hoxsey is followed a few months later by one in which Barnes mentions the creation

of a trust fund for Hoxsey's family—he was killed in a crash on December 31, 1910. Other letters arrange \$12,000 to cover funeral expenses and a trust fund for the family of Ralph Johnstone, killed while demonstrating a Wright flying machine.

Letters also discuss the first female passenger of an aircraft, whether to take on a black student, how to guard the Wrights' patents, and even how to skew aircraft part prices to favor the Wrights' customers over competitors'.

The collection adds clarity to the Wrights' years in the aviation industry. "The history books are often wrong," says Parks. "There's material for four or five new books in these documents."

The papers refute, for instance, what appears in most aviation history books: that the Glenn L. Martin Company merged with the Wright Company in 1915. Instead, Parks says, records from both companies (the collection also includes early Martin and Curtiss Aeroplane

Company materials) show their boards meeting separately a year later, an indication that the companies remained independent for some time after the supposed merger. The papers also reveal that the Wrights' sister, Katharine, played a much more prominent role as secretary for the company's executive committee than previously thought, and records of the dates and locations of flying exhibitions open a window on what had been the undocumented business of pre-1914 barnstorming.

Despite its obvious significance, the collection nearly met with an unremarkable end. For decades the papers were filed away at the Curtiss-Wright Corporation, a descendant of the Wright Company and a business begun by Glenn Curtiss, the brothers' one-time rival. Then, in the early 1990s, aviation



*Curator Dennis Parks: "Here they are with Wilbur and Orville's signatures...how money is to be spent and how they made decisions."*

collector Joseph Gertler got a call from a former Curtiss-Wright employee who had an amazing story: He'd saved boxes of documents signed by the Wrights from the garbage can when company offices had been cleaned out. Gertler was initially skeptical, but after a week he called back and asked to see the papers. When he did, he realized how important they likely were, and in 1993, after lengthy negotiations, acquired the collection.

Though he was determined to get the papers into public hands, museums balked when he floated his initial asking price of \$900,000. According to Parks, however, that was a bargain; single letters could have easily fetched \$1,000 (far more if they bore Orville or Wilbur's signatures), and the entire collection, sold letter by letter, might have garnered close to \$2 million. "Although I had had several offers to buy different items piecemeal, I had never offered them [that way]," says Gertler. "I

only expressed hope that they could eventually be acquired by a major institution, as a unit."


Finally, in 1999, with the centennial of the Wrights' first flight approaching, the Museum of Flight, backed by anonymous donors, put together a still-undisclosed winning bid.

"It's quite a coup for the Museum of Flight to have this collection," says Crouch. "Everybody wanted it—the Library of Congress, Wright State, and others." According to Crouch, the National Air and Space Museum was also interested, but found the collection too expensive.

In Seattle, the Museum of Flight is building an exhibit around the Wright papers. Opening in December 2003, "The Birth of an Industry" will illustrate the struggles

and triumphs of aviation's early years.

The industry eventually prospered, but not in time to help Orville. For three years after Wilbur died of typhoid fever in 1912, he managed the company and devoted himself to legal battles protecting the Wright patent, which covered nearly all aspects of controlling a powered aircraft. Perhaps because Wilbur believed that changes to basic designs would invalidate their patent, the brothers' airplanes failed to evolve. Europe seized the initiative, and by 1914 European manufacturers, supported by governments arming for war, were turning out 100-mph fighters and multi-engine bombers while the Wright Company was still marketing its relatively primitive Model C Flyer.

It was inevitable that the company would fail. On August 26, 1915, Orville sold it for \$250,000, just one-quarter of its initial capitalization. Records of the sale can be found among the collection too—poignant reminders that success in the business of aviation has always been tough to achieve, even for the men who invented it. 

# 100 Ways to Celebrate Years of Flight

Airshows, air races, museum exhibits and traveling shows, books, Web sites, films and television programs—even musical productions—all commemorate the Wright brothers' feat of a century ago. Throughout the year, events have been scheduled across the United States and in nearly every place in the world that flight has touched. Here's a list of performances to attend, places to visit, and products to buy to help you observe the anniversary of the first flight.

BY ROGER A. MOLA



## Kitty Hawk, North Carolina

For the December 17, 2003 reenactment of the first flight, book a hotel room now. The Outer Banks offers four times as many private rentals as traditional hotel rooms, and Sun Realty manages more than 1,300 of those choices—400 within 10 miles of the Wright Brothers Memorial. [www.sunrealtync.com/2003-centennial.htm](http://www.sunrealtync.com/2003-centennial.htm) or 800-334-4745

## Dayton, Ohio

For the Inventing Flight festival in July, reserve one of the 7,000 rooms available in the Wright brothers' hometown and in surrounding Montgomery County, spread among 70 hotels, motels, and B&Bs. 800-221-8235

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RESERVE A ROOM AND A RUNWAY IN NORTH CAROLINA AND OHIO!



## Washington, D.C.

Behold the machines that started it all. The National Air and Space Museum will take the original 1903 Wright Flyer down from its roost for a special exhibit opening this fall. The 1909 Wright Military Flyer and 1911 Vin Fiz are also on display. [www.nasm.si.edu](http://www.nasm.si.edu) or [www.nasm.edu/galleries/gal100/wright1903.html](http://www.nasm.edu/galleries/gal100/wright1903.html)

## Kitty Hawk, North Carolina

Fly over the town from adjacent Dare County Regional Airport in Manteo, NC. Fly in year-round, but tie-downs on December 17 cost as much as \$160 a day. [www.fly2mqi.com](http://www.fly2mqi.com) or 252-473-2600

## Dayton, Ohio

Hook a landing slot at Dayton International or any of 14 airports within an hour's drive, from Xenia Greene County to Middletown Hook Field to Ohio State University in Columbus. [www.inventingflight.com/visitor/partner\\_airports.php](http://www.inventingflight.com/visitor/partner_airports.php)

### Tucson, Arizona

Start a diet—if you want to save money on dime-a-pound airplane rides from the Ninety-Nines, Inc. They'll be at the International Organization of Women Pilots at Ryan Airfield's Aviation Day Celebrating a Century of Flight, March 1. [www.tucsonairport.org](http://www.tucsonairport.org) or 520-573-8100

### Lakeland, Florida; Dearborn, Michigan; Dayton, Ohio; Oshkosh, Wisconsin; Seattle, Washington; Kitty Hawk, North Carolina

See Virginia craftsman Ken Hyde's replica 1903 Wright *Flyer* perform at any of six events beginning with the Sun 'n Fun airshow in April and concluding with December 17's first flight reenactment at Kitty Hawk. <http://countdownto.kittyhawk.org>

Book a flight on Midwest Express or Alaska Airlines and pull from the seat back a free magazine, *Celebrating a Century of Flight*, developed by the U.S. Air Force and NASA.

### Richmond, Virginia

Sashay through the Virginia Aviation Museum for a look at Rick Young's replicas of the Wrights' creations, from the 1899 kite to the 1903 *Flyer*. You'll see 23 other airplanes, including a 1928 Pietenpol Aircamper and a Lockheed SR-71 Blackbird on loan from the Air Force Museum. [www.vam.smv.org](http://www.vam.smv.org)

### College Park and Baltimore, Maryland

Sing along to "Right Place, Right Time, Wright Brothers," a musical of 16 numbers celebrating Orville, Wilbur, and their sister Katharine, at Maryland's College Park Aviation Museum on March 22 and November 15 and at the Baltimore Museum of Industry Theatre on the Harbor on June 7. Call 410-727-4808, ext. 112, for tickets or to schedule a performance.

### Paris, France, and Dayton, Ohio

Admire 150 rare photographs of the brothers and their milieu at Musée de l'Air at Le Bourget, April 1–June 22. Can't make the Seine? The collection visits Dayton Art Institute from July 4 through September 30. [info@daytonartinstitute.org](mailto:info@daytonartinstitute.org) or 800-296-4426. In Dayton, don't miss the new John Safer sculpture "Pathway," a 70-foot monument to Orville and Wilbur.



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### Merritt Island, Florida, to San Diego, California

Follow the "modern representation" of the Wright *Flyer* built by the American Institute of Aeronautics and Astronautics as it makes 10 tour stops, from the Kennedy Space Center in March to Legoland California in October. [www.wrightflyer.org](http://www.wrightflyer.org) or <http://quest.arc.nasa.gov/aero/wright>

Download the 2003 U.S. and Canadian airshow schedules from the International Council of Air Shows and count the number of events with "centennial" in their titles. [www.airshows.org](http://www.airshows.org)

Read hundreds of essays on early flight and check out centennial-theme events for every month of 2003, assembled by the U.S. Centennial of Flight Commission. [www.centennialofflight.gov](http://www.centennialofflight.gov)

### Philadelphia, Pennsylvania

Explore the country's largest collection of Wright workshop artifacts at the Franklin Institute Science Museum Wright Festival, March 28–30. Call 215-448-1200 or visit [www.fi.edu/wright](http://www.fi.edu/wright) for "Flights of Inspiration," including Quicktime animations of Wright craft, downloadable original drawings, and photographs. **K**

### The Plains, Virginia

Root for a rocket May 10, cheering high school teams to win \$50,000 in prizes for launching models under 3.3 pounds carrying two raw eggs to 1,500 feet. To celebrate the centennial, the Aerospace Industries Association teamed with the National Association of Rocketry to sponsor the first national model rocket challenge. [www.aia-aerospace.org](http://www.aia-aerospace.org) or 202-371-8400 **KL**

Go for the gold, with one of 100,000 \$10 gold proof and uncirculated Orville and Wilbur Wright commemorative coins to be issued by the U.S. Mint on August 1. On a budget? Choose one of 500,000 silver dollars or 750,000 silver-clad half-dollars. [www.usmint.gov/mint](http://www.usmint.gov/mint) or 1-800-USA-MINT (872-6468)

#### KEY



Events



Exhibits



Activities



Web Sites



Products



Kid-friendly



AMCC

## Dayton, Ohio

Buy a brick for \$50.00 or bust out \$30,000 to fund the bust of Charles E. Taylor, mechanic and engine builder for the Wrights. Groundbreaking for Taylor's memorial takes place on his birthday, May 24, in front of Dayton's Wright State University Library. Each anniversary, the names of aviation maintenance technicians who have received the Federal Aviation Administration's Master Mechanic award will be added to those of the initial 800 names on the memorial. [www.amccommission.com](http://www.amccommission.com) or call Aviation Maintenance Career Commission executive director Neva Newby, 336-495-3190.

## Fayetteville to Wilmington, North Carolina

Stay a spell in Carolina for airshows, celebrations, coastal and mountain air tours, and formation flyovers in 23 North Carolina cities from May 3 through early June. See the master schedule at [www.worldflight2003.com](http://www.worldflight2003.com).

## Fayetteville

Condense a century of aviation into 11 days of events highlighting five themes—from humanitarian flight to combat aircraft—at the Festival of Flight airshow, May 16–26. [www.festivalofflight.org](http://www.festivalofflight.org)

## Hot Springs, Arkansas

Soak safely at the 100th Anniversary of Aviation and Aviation Safety Celebration, June 12–15, at Hot Springs National Park. The weekend will be bubbling with antique aircraft displays, a fly-in, and a seminar. [www.AvHotSp2003.org](http://www.AvHotSp2003.org) Fly-ins welcome. Call Carl and June Borchers at 501-760-5144 or e-mail Carl at [BorchMrB@aol.com](mailto:BorchMrB@aol.com).

## Nashville, Tennessee

See a Wright Model B and learn what Arnold Air Force Base and Tullahoma Regional Airport, 45 miles southeast of Nashville, contributed to ground testing support for NASA at the Centennial of Flight airshow, June 21 and 22. [www.arnoldafbairshow.com](http://www.arnoldafbairshow.com) or call Murray King, 931-454-6654.

## Somewhere in Indiana

Wander where Wilbur was born in rural Henry County between New Castle and Hagerstown. The birthplace is open April through October and by appointment November through March. Stop in June 20–22 for the centennial celebration, including hot air balloons, helicopter tours, and a ham and bean supper. [www.wilburwrightbirthplace.com](http://www.wilburwrightbirthplace.com) or 765-332-2495

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NOTHING COULD BE FINER  
THAN AIRSHOWS IN CAROLINA!

## Wright-Patterson Air Force Base, Ohio

Marvel at 40 early flying machines, including a 1909 Wright model, plus 250 modern ones, at the U.S. Air Force Museum. Get directions plus 3,000 pages of photos, facts, and links at [www.wpafb.af.mil/museum](http://www.wpafb.af.mil/museum). Visit on May 10 or 11 and see the Air Power 2003 airshow; 937-255-3334.

## Lumberton

Discover the Wrights' approach to invention May 14–18, with exhibits and an airshow at Lumberton Municipal Airport, presented by Robeson Aeronautical Foundation. [www.celebrationofflightnc.com](http://www.celebrationofflightnc.com)

## Charlotte/Concord

Tighten your alternator belts for a month-long celebration of aviation maintenance. Attend a career festival, rev up for the world aviation maintenance technician Olympics, and, on May 25, enjoy a pre-race show for professional aviation mechanics at Lowe's Motor Speedway. [www.worldflight2003.com](http://www.worldflight2003.com)

## California City, California, to Kitty Hawk, North Carolina

Thumb your nose at powered flight by soaring across the country in 10 legs from June 17 to July 4. The Soaring Society of America will include 50 glider pilots in its "Return to Kitty Hawk: the Great Transcontinental Glider Race," pausing at Las Cruces, New Mexico; Dallas; Indianapolis; Roanoke, Virginia; and at least five other towns every 300–500 miles, depending on the winds. Follow in person or online. [www.ssa.org](http://www.ssa.org)

## Los Angeles, California

Sing "Happy Birthday" to Los Angeles International Airport at its 75th birthday party and check out the Van Nuys Airport Aviation Expo, June 21 and 22, featuring the AIAA 1903 Flyer replica. See Los Angeles World Airports at [www.lawa.org/vny/html/aviation\\_expo.html](http://www.lawa.org/vny/html/aviation_expo.html)

## Hampton, Georgia

Start your engines August 7 through 10 at the Atlanta Motor Speedway for the Incredible Age of Aviation show: replicas of the 1783 Montgolfier brothers' balloon, flying replicas of eight of the Wright brothers' aircraft, concerts, and a fantasy-shape-balloon parade over downtown Atlanta. [www.flightlineairshows.com](http://www.flightlineairshows.com) or 770-529-0030



## Dayton, Ohio, to Kitty Hawk, North Carolina

Duck! as "the closest kin to the Wright *Flyer* in modern aviation" putter 500 feet overhead, June 22–28, in "A Celebration of Flight Cross-Country Ultralight" trip. At least 40 pilots will average 50 mph on the 1,300-mile round trip, usually in early morning or evening. Contact Richard Jennings at [jennings@wpafb.af.mil](mailto:jennings@wpafb.af.mil), 957-256-2211, or [www.daytontokittyhawk.com](http://www.daytontokittyhawk.com)

PAUL BEARDSLEY

Test your skills with one of these online simulations of the Wright *Flyer* (visit our Web site, [www.airspacemag.com](http://www.airspacemag.com), for more): <http://wright.grc.nasa.gov/sim.htm> to fly Wright aircraft from 1900 through 1905; <http://firstflight.open.ac.uk> for one of the best *Flyer* simulations along with programs for competitive pre-1910 models.

Go to Wright School, as NASA teaches it, with interactive simulations, CD-ROMs, biographies, photo galleries, streaming video, and Webcasts. [www.grc.nasa.gov/WWW/Wright](http://www.grc.nasa.gov/WWW/Wright)

Build a styrofoam replica Wright *Flyer* to FAA standards of safety. Download plans from [www2.faa.gov/education/resource/1903fly.htm](http://www2.faa.gov/education/resource/1903fly.htm)

## Washington, D.C.

Visit the Library of Congress Special Collections or review online its holdings of letters, diaries, and hundreds of photos of the earliest flights, digitized for the catalog and available as 8- by 10-inch prints from the original glass plate negatives. <http://memory.loc.gov/ammem/collections/finder.html> and [www.loc.gov/rr/print/coll/236\\_wright.html](http://www.loc.gov/rr/print/coll/236_wright.html)

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Is it true that if you look close enough at the 1903 photos of the Wright *Flyer* you'll see the Outer Banks "OBX" bumper sticker? You can get one for yourself or an OBX Frisbee, key chain, or T-shirt. [www.kittyhawk.com/gifts](http://www.kittyhawk.com/gifts)

Keep track of Kitty Hawk time plus one other with the brass dual-zone Wright brothers *Flyer* clock, \$112.50 from Bulova's Smithsonian collection. Style no. B6210 from Someone Special. [www.someonespecial.com](http://www.someonespecial.com) or 800-237-7656

Send \$10.00 to the Wright State University Libraries in Dayton, Ohio, for an information packet containing copies of primary and secondary sources from the world's most substantial Wright collection. Limited number of free posters and bookmarks. [www.libraries.wright.edu/special/wright\\_brothers/packet/request.html](http://www.libraries.wright.edu/special/wright_brothers/packet/request.html) Arrange to visit Special Collections and Archives or just surf at no charge: [www.libraries.wright.edu](http://www.libraries.wright.edu).

Go fly a kite! A homebuilt Wright *Flyer* kite of five-foot wingspan from Stratton Kites, product no. 564 at [www.intothewind.com](http://www.intothewind.com), or call Into the Wind, at 800-541-0314. Find fancier models from Incunabula, [www.museumseries.com/kite.htm](http://www.museumseries.com/kite.htm). For a cheap date, download free plans for the 1899 Wright Kite or the Not Quite Wright Kite from Wright Brothers Aeroplane Company. [www.first-to-fly.com/Adventure/Workshop/1899\\_wright\\_kite.htm](http://www.first-to-fly.com/Adventure/Workshop/1899_wright_kite.htm)

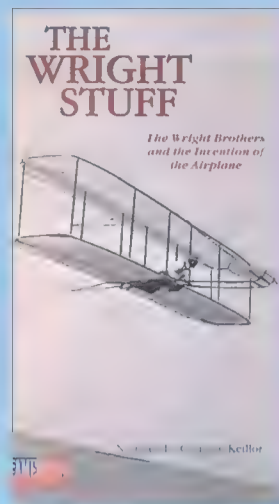
Spend an hour (easily) browsing 301 Wright photos, piloting a simulated Wright *Flyer*, viewing QuickTime animations and 3D models of early aircraft, and linking to biographies of dozens of early aviators at "To Fly Is Everything," an educational Web site. [http://invention.psychology.msstate.edu/air\\_main.shtml](http://invention.psychology.msstate.edu/air_main.shtml)

Stump NASA experts with your questions or solve puzzles for young fans of the Wrights. <http://quest.arc.nasa.gov/aero/wright/kids/slider/puzzle.html>



Thumb through 144 pages listing every title published about the Wright brothers in the last 100 years. *Wilbur & Orville Wright: A Bibliography Commemorating the One Hundredth Anniversary of the First Powered Flight on December 17, 1903* is free from NASA. Request item SP-2002-4527; send an SASE and \$3.95 postage to NASA Headquarters Information Center, Code CI-4, Washington, DC, 20546.

Collect a postcard of the Wright Flyer, printed from a plate etched by a master engraver; \$6.50 from the U.S. Department of the Treasury, Bureau of Engraving and Printing. [www.bep.treas.gov/store/section.cfm/71/92/395](http://www.bep.treas.gov/store/section.cfm/71/92/395) or call 202-874-3019.



Buy a video copy of *The Wright Stuff*, a 1996 documentary produced by WGBH Boston for "The American Experience." Narrated by Garrison Keillor, the one-hour VHS is \$19.95 from WGBH Shop. <http://pbs.org/wgbh/pages/amex/wright>. And, free from PBS: a Quicktime film, *Return to Kitty Hawk*. [www.pbs.org/wgbh/amex/wright/return.html](http://www.pbs.org/wgbh/amex/wright/return.html)

Applaud Wright aircraft replicas and today's Air Force originals as they fly by at the Vectren Dayton International Air Show, presented by Kroger, July 17–20. Daily performances by the French national aerobatic team. [www.usats.org](http://www.usats.org)

### Kitty Hawk, North Carolina, to Oshkosh, Wisconsin

Wave at the pilots in the EAA AirVenture Cup, a 1,000-nautical-mile race, July 27 and 28, with a pylon-turn pit stop in Dayton. All racers must fly experimental-category aircraft. [www.eaa.org](http://www.eaa.org) or [www.countdowntokittyhawk.org/airventure\\_cup.html](http://www.countdowntokittyhawk.org/airventure_cup.html)

**Dearborn, Michigan**  
Hitch a ride (for a fee) in a 1920s airplane when it stops at one of 24 cities along the 4,000-mile National Air Tour to and from Dearborn, September 8–24. The Aviation Foundation of America will re-create the Ford Air Tours of 1925–1931 with 25 aircraft, from tri-motors to flying boats. Pick your stop on the tour route, listed at [www.NationalAirTour.org](http://www.NationalAirTour.org), or call 651-255-1999.

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Watch an airplane parade! 100 airplanes, including Wright airplane replicas, wind through the streets of New Carlisle, OH, on July 4. 937-222-0065

### Dayton, Ohio

Descend on Dayton on any of 17 days of the Inventing Flight festival, July 3 through July 20, featuring exhibits, technical symposia, international arts and sports events, dramatic reenactments of life in 1903, and daily flyovers by craft from every era, including the one-man Exoskeletar. For a schedule, visit [www.inventingflight.com](http://www.inventingflight.com), or call 937-222-0065.



Float your bets for one of 100 competitors in the Historic Balloon Launch and Race from Dayton to Kitty Hawk, July 4–7. Stick around for the International Blimp Meet and Race, July 11–13, which is attempting a world record for gathering the most blimps in one place. Call Kendra Dickerson, 937-222-0065, ext.26, or visit [kdickerson@inventingflight.com](mailto:kdickerson@inventingflight.com).

### Gloucester, England

Camp among a living-history display of aircraft that have pushed the frontiers of military flight in its first century, July 18–20, at the Royal International Air Tattoo, Fairford. Royal Air Force, Navy, and Army will stage a vast mock battle in a fictional land, "Riattica," employing actual military strategies and tactics. [www.airtattoo.com](http://www.airtattoo.com)



### Seattle, Washington

Scan the papers of the Wright Airplane Company at the Museum of Flight: 875 unpublished Wright letters, Wright Company ledgers and technical documents (see "Aviation's Birth Certificate," p. 78). The exhibit opens in September and includes Glenn Martin company and Curtiss Aeroplane Company archives. [www.museumofflight.org](http://www.museumofflight.org) or 206-764-5720

### Kitty Hawk, North Carolina

Sponsor a pylon for \$20,000, or kick in one of 6,566 bricks at \$100.00 a piece, for the new Monument to a Century of Flight, to open on Kitty Hawk Heritage Day, September 27. Outer Banks artist Glenn Eure and sculptors Hanna Jubran and Jodi Hollnagel designed the monument of 14 matte stainless steel pylons to represent an orbit of 120 feet in tribute to the Wrights' feat. [www.icarusinternational.com](http://www.icarusinternational.com) or 252-441-6584

Top your coffee table with *Flight: 100 Years of Aviation*, 440 pages and thousands of photographs, a National Air and Space Museum collaboration with publisher Dorling Kindersley, \$50.00 1-877-342-5357, or with *Wright to Fly: Celebrating 100 Years of Powered Flight*, 224 pages with 100 whole-page paintings, hardbound and encased in sateen with satin marker: £39 from Royal Air Force Benevolent Fund Enterprises, Royal Aeronautical Society and the Imperial War Museum. Product code 970152, phone (44) 08700143322



JIM KOEPNICK/FAA

### *The Aviation Foundation of America's Ford Tri-motor.*

Protect against the December chill as Orville and Wilbur must have done. But they didn't have a Wright Brothers Memorial Throw. Cotton, machine-washable coverlets are 60 x 48 inches with fringe on four sides. \$53.95. At [www.yahoo.com](http://www.yahoo.com), search for "wright brothers blanket."

### **Dayton, Ohio**

Pay your respects to Wilbur and Orville, their sister Katharine, and parents Milton and Susan Wright with an audio cassette tour of Woodland Cemetery and Arboretum. The cemetery's hill offers a panorama of Dayton. [www.woodlandarboretum.org](http://www.woodlandarboretum.org)

Read Orville Wright's 1908 article for *Century* magazine, "How We Made the First Flight." [www.aero-web.org/history/wright/wright.htm](http://www.aero-web.org/history/wright/wright.htm)

Tap an array of interactive resources and links at the Centennial Museum Online and Wright Brothers Aeroplane Company, including a virtual tour of all 19 Wright aircraft types produced from 1903 through 1916. [www.Wright-Brothers.org](http://www.Wright-Brothers.org) or [www.first-to-fly.com](http://www.first-to-fly.com)

Flap with the Early Birds of Aviation, dedicated to the preservation of pioneer aviation history, <http://earlybirds.org/index.html>. Download three-views and plans to build pioneer aircraft models, via <http://earlybirds.org/menu.html>.



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Cuddle a First Flight Centennial bear cub named *Monument or Flyer*, \$9.95; a portion of the proceeds goes to the First Flight Centennial Foundation. The nine-inch bears are embroidered and tagged with facts about the landmark flight; from LERC, Inc. of Spring Hope, NC. Airplane and goggles not included. [www.lerc-inc.com](http://www.lerc-inc.com) or [www.firstflightcentennial.org](http://www.firstflightcentennial.org)

### **Dayton, Ohio**

Drive the Aviation Trail: a self-guided tour of 45 aviation landmarks centered on Dayton and Miami Valley, Ohio. Download a map and tips via <http://aviationtrailinc.org>, or call for a free brochure at 937-443-0793. At the Wright Cycle Company, pick up a copy of *A Field Guide to Flight: On the Aviation Trail in Dayton, Ohio* (second edition) by Mary Ann Johnson (Landfall Press, 1996).

### **Dearborn, Michigan**

Drop in on the Wrights' bicycle-making and printing businesses at the Henry Ford Museum and Greenfield Village. [www.hfmgv.org/exhibits/wright](http://www.hfmgv.org/exhibits/wright)



HENRY FORD MUSEUM

Shhhh!...Enjoy rare Wright brothers photos, postcards, and scrapbooks, but please keep it down in the Dayton and Montgomery County Public Libraries. Directions at <http://home.dayton.lib.oh.us/archives/WBCollection/WBExhibit.html>.

### **Dayton, Ohio**

Examine the 1905 Wright Flyer III, restored by Orville and considered the first practical airplane, at the 65-acre Carillon Historical Park. [www.carillonpark.org](http://www.carillonpark.org) or 937-293-2841

### **Miramar, California**

Wade ashore at Marine Corps Air Station Miramar for "Kitty Hawk to Miramar—100 Years of Flight." The airshow includes a mock assault by the Marines and a flying demonstration by the U.S. Navy Blue Angels, October 17–19. [www.miramarairstow.com](http://www.miramarairstow.com) or 858-577-1016.



CARILLON HISTORICAL PARK



LERC, INC.

## Daytona Beach, Florida

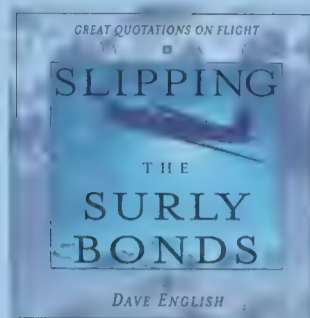
Leave your footprints in warmer sands than Kitty Hawk. On November 8 and 9, Embry-Riddle Aeronautical University presents an airshow: Wings and Waves 2003: Embry-Riddle Celebrates the Centennial of Flight. [www.embryriddle.edu](http://www.embryriddle.edu)

## Owls Head, Maine

Measure the 1903 *Flyer* against 27 other aircraft designed between 1804 and 1946 at the Owls Head Transportation Museum. The collection of replicas also includes a 1909 Blériot XI, 1910 Henri Farman III biplane, and 1913 Etrich Taube. [www.ohtm.org](http://www.ohtm.org) or 207-594-4418

## London, England

Accept an invitation from His Royal Highness the Prince of Wales to join the Royal Aeronautical Society (founded in 1866) and celebrate the centennial across the pond. Check the list of events at [www.100yearsofflight.org.uk](http://www.100yearsofflight.org.uk).



Memorize famous aviation quotations, including this 1901 thought from H.G. Wells: "Long before the year 2000 A.D., and very probably before 1950, a successful aeroplane will have soared and come home safe and sound." Choose your favorites from *Slipping the Surly Bonds: Great Quotations on Flight* (compiled by Dave English, McGraw-Hill, 1998).

Give 100 of your best buddies a book: *First Flight: The Wright Brothers and the Invention of the Airplane*, from the U.S. Department of the Interior. Order from the Government Printing Office, stock number 024-005-01212-5 or bibliographic item 016CF 018FJ. Sold individually for \$6.00, but a deal on 100: \$205.50! <http://bookstore.gpo.gov>

## Contemporaries

Learn about other inventors vying to be the first to fly. Nearly all boast their own museums, Web sites, and resources. [www.100aviators.com](http://www.100aviators.com) or [www.first-to-fly.com/History/Wright%20Story/prizepatrol.htm](http://www.first-to-fly.com/History/Wright%20Story/prizepatrol.htm) or [www.ctie.monash.edu.au/hargrave/pioneers.html](http://www.ctie.monash.edu.au/hargrave/pioneers.html)

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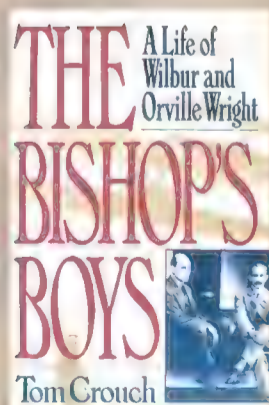
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Read Tom Crouch's biography, *The Bishop's Boys: A Life of Wilbur and Orville Wright*, WW Norton & Co., 1989. (See "Meeting Orville and Wilbur," p. 28; for more books about the Wright brothers, see Reviews & Previews, p. 98.)



Hire an Orville impersonator. Jim Spence plays Orville in full costume at airshows or corporate bashes. [www.orvillewright.com](http://www.orvillewright.com) or 614-861-6364

Color the drawings of 47 aircraft, including the Concorde and the *Spirit of St. Louis*, in Dover Press' *History of Flight Coloring Book* by A.G. Smith. \$3.95. <http://store.doverpublications.com>

Start the cult following for *The Wright Brothers*, an unusual (to say the least) feature film in which Orville is played by a woman and Grateful Dead lyricist Robert Hunter makes his acting debut. The 1997 film (103 minutes), by Gregg Lachow and Wiggly World Studios, won the Judges Award at the Northwest Film Forum. For a schedule of screenings, contact Michael Seiwerath, Northwest Film Forum, [michael@nwfilmforum.org](mailto:michael@nwfilmforum.org); 206-329-2629.

## Polk City, Florida

Preview December's 100th anniversary recreation flight with a flashback to the 75th. View the 1903 Wright *Flyer* built by Ken Kellett Aircraft and flown in 1978 at Kitty Hawk; on display at the 300-acre Fantasy of Flight Museum, halfway between Orlando and Tampa. The replica starred in *Quest for Flight*, which won an Emmy. [www.fantasyofflight.com](http://www.fantasyofflight.com) or 941-984-3500

## Hammondsport, New York

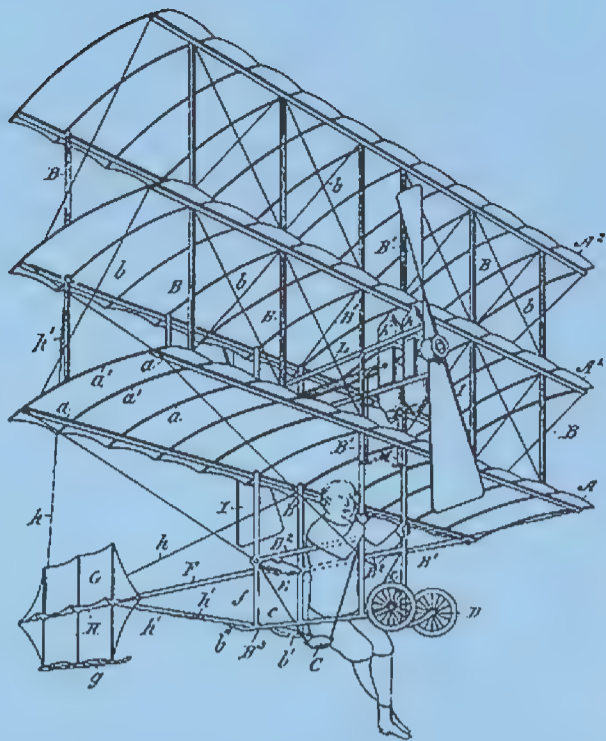
Sip wine at bucolic upstate New York wineries before visiting the Glenn Curtiss Museum. Curtiss has been called the Father of Naval Aviation, and he wasn't bad with a motorcycle either. [www.glenncurtiss.com/links.htm](http://www.glenncurtiss.com/links.htm)



## Windsor Locks, Connecticut

Back up a century to the late 19th: A replica of the 1896 Chanute-Herring glider hangs in the New England Air Museum. [www.neam.org/exhibits.htm](http://www.neam.org/exhibits.htm) Or read all about it: More about the gliders of Augustus Moore Herring can be found on the Web. [www.flyingmachines.org/chan.html](http://www.flyingmachines.org/chan.html)

Locate 10 replicas and facts about Octave Chanute's 1896 hops from the Indiana dunes. [www2.crown.net/sspicer/chanute/chan\\_ind.html](http://www2.crown.net/sspicer/chanute/chan_ind.html)



Find inspiration in the work of glider pioneer Otto Lilienthal, as the Wrights did. Take a real or virtual tour of the Lilienthal Museum in Germany. [www.lilienthal-museum.de](http://www.lilienthal-museum.de) or <http://invention.psychology.msstate.edu>

Inspect the 1907 designs of Gabriel Voisin at [www.centennialofflight.gov/essay/Aerospace/earlyFrance/Aero46.htm](http://www.centennialofflight.gov/essay/Aerospace/earlyFrance/Aero46.htm).

Learn about the mixture of cars, cash, and daring in Louis Blériot's career. In 1901 Blériot poured profits from his automotive headlamp company, along with his wife's inheritance, into an ornithopter design and into monoplanes that eventually enabled him to make the historic flight over the English Channel. <http://bleriot.com>

## Murfreesboro, North Carolina

Hunt the "turkey buzzard," a replica of the 1873 contraption built by James Henry Gatling, elder brother of Gatling gun inventor Richard. Gatling's Aeroplane consisted of fuselage, wings, steering mechanism, and an elevator apparatus, but flew only 100 feet before a wing separated. Find a re-creation at the Transportation and Agriculture Museum; [www.murfreesboronc.com](http://www.murfreesboronc.com) or 252-398-5922

Tickle the ivories with "The Aviation Rag," composed by Mark Janza (pen name for Al F. Marzian). One part is as close as pianos get to a rough landing. Listen to the rag via "Perfesser" Bill Edwards' Web site. [www.perfessorbill.com/index1.htm](http://www.perfessorbill.com/index1.htm) Or download sheet music from [www.libraries.colorado.edu/cgi-bin/sheetmusic.pl?RagAviation&Rag&main](http://www.libraries.colorado.edu/cgi-bin/sheetmusic.pl?RagAviation&Rag&main).



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LEARN ABOUT OTHER INVENTORS VYING TO BE THE FIRST TO FLY.

## Gary, Indiana

Find the spot on the Indiana shore of Lake Michigan where Octave Chanute and Augustus Moore Herring conducted glider experiments in 1896. Today, roads and houses sit atop the dune, but an aquatorium and Octave Chanute & Tuskegee Airmen Museum are nearby in Marquette Park; 219-938-8081.

Sport a wristwatch to commemorate the career of Alberto Santos-Dumont, the first man to wear one. In the fall of 1906, the wealthy Brazilian made the first powered flights in Europe. Designed for him by his friend Louis Cartier, the Santos de Cartier is still available from the luxury watchmaker. Price: If you have to ask... <http://firstflight.open.ac.uk/santos/santosqtrv.html>

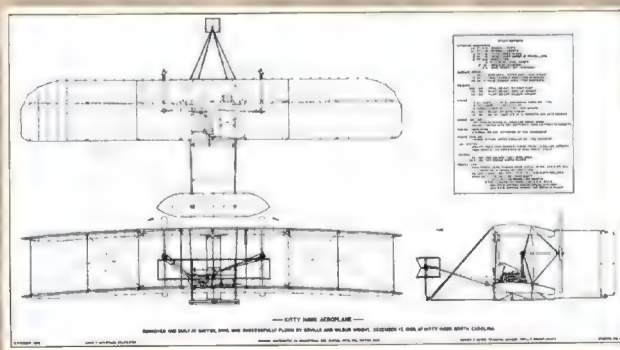
Wave your beret for Ferdinand Ferber and French aviation pioneers at [www.flight100.org/history/fra.html](http://www.flight100.org/history/fra.html). Ferber designed and flew a powered aircraft on May 27, 1905, a flight considered by many to be the first European flight of a stabilized and controlled airplane.

## Bridgeport, Connecticut

Investigate the claim by Gustave Albin Whitehead (1874–1927) that he flew before the Wrights. Visit his hangar at Captain's Cove Seaport. [www.captainscoveseaport.com/attractions.htm](http://www.captainscoveseaport.com/attractions.htm) His flight in a powered aircraft was said to have covered 1.5 miles over Long Island Sound on August 14, 1901; earning him a museum in his German homeland. [www.weisskopf.de/research.htm](http://www.weisskopf.de/research.htm)

Head outdoors to fly your Wright *Flyer* models from \$14.95 through \$69. [www.first-to-fly.com/Adventure/Workshop/modelkits.htm](http://www.first-to-fly.com/Adventure/Workshop/modelkits.htm) The line ranges from a 1:48-scale craft powered by rubber bands to a 1:12-scale 1903 radio-control model with dual electric motors. Dare Design and Engineering; 800-578-3273. [www.darehobby.com/Wright\\_Flyer.htm](http://www.darehobby.com/Wright_Flyer.htm) or [www.darehobby.com/Wright\\_Glider.htm](http://www.darehobby.com/Wright_Glider.htm)

Paper your room with the 50 drawings created by the National Air and Space Museum during its 1985 restoration of the Wright *Flyer*. Each of the 50 prints costs \$4.20 plus shipping (or purchase the set for \$75). Blueprints showing a three-view are available for free as a PDF online. [www.nasm.si.edu/nasm/arch/wrights.htm](http://www.nasm.si.edu/nasm/arch/wrights.htm)





### Blaine, Minnesota

Gaze at the lovely 1911 Steco Aerohydroplane, which accomplished turning by an empennage flight control system instead of wing warping. The Steco is now undergoing restoration in the American Wings Air Museum at the Anoka County/Blaine airport. [www.aerofiles.com/stecox.jpg](http://www.aerofiles.com/stecox.jpg)

Connect the dots of history with a downloadable, 24-page PDF booklet entitled *Historical Aircraft Connect-the-Dots*. Available from the Minnesota Department of Transportation Office of Aeronautics: Click on "Students" then "Activity Book." [www.mnaero.com/aved](http://www.mnaero.com/aved)

Pour a glass of milk, then construct the Incredible Edible Wright Flyer using graham crackers, pretzel sticks, and frosting. Recipe from NASA's Kids Science News Network. Dunking may affect aerodynamics. <http://ksnn.larc.nasa.gov/aeroplane/activity.html>

Tune in online to National Public Radio segments on the Wright brothers. Hear "The Wright Brothers' First Glider Flight" at <http://search.npr.org/cf/cmn/cmnps05fm.cfm?SegID=112864> or "Inventing Airplanes" at <http://discover.npr.org/features/feature.jhtml?wfld=1150613>.

### London, England

Attend the annual Orville and Wilbur Wright lecture at the Royal Aeronautical Society, Hamilton Place on December 5 and the opening of the extension to the Royal Air Force Museum at Hendon on the 17th. Watch the ceremony live by satellite in the Kitty Hawk Visitor Center, [www.100yearsofflight.org.uk](http://www.100yearsofflight.org.uk); for more information, e-mail [gail.broadbent@raes.org.uk](mailto:gail.broadbent@raes.org.uk); or call (44) 020 7670 4300.

### Kitty Hawk, North Carolina

Stand on hallowed sand on December 17, 2003. The First Flight Centennial Celebration runs from December 13 to 17, hosted by the National Park Service, Experimental Aircraft Association, NASA, and the U.S. Air Force, among others. Kitty Hawk will enjoy daily flyovers, VIP speakers, static aircraft exhibits, and performing arts within a centennial exhibit pavilion on the park grounds. Visit the Wright Brothers National Memorial, Highway 158, Milepost 8.5, Kill Devil Hills, North Carolina. Call the Outer Banks Visitors Bureau at 800-446-6262, e-mail [visitorinfor@outerbanks.org](mailto:visitorinfor@outerbanks.org), and visit [www.countdowntokittyhawk.com](http://www.countdowntokittyhawk.com) and [www.outerbanks.org](http://www.outerbanks.org).



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Don't be a blockhead: Order *The Wright Brothers at Kitty Hawk: This Is America, Charlie Brown*. The Peanuts gang helps Orville and Wilbur get off the ground, but Charlie Brown crashes his kite. The Wrights teach him that failures lay the groundwork for successful flight. \$11.95 on VHS, from e-parks and the Wright Brothers National Memorial. [www.eparks.com/eparks/park\\_entrance.asp?park=14W](http://www.eparks.com/eparks/park_entrance.asp?park=14W) or 877-NAT-PARK



Watch the Wrights showing Europe to fly, Wilbur setting an altitude record, and more rare footage available for free online. <http://invention.psychology.msstate.edu/gallery/airphotos.html>

Laugh yourself silly by logging on to a Web site created by humor columnist Tim Bete in honor of the centennial. Submit jokes and humorous stories about flight; you may win a T-shirt. [www.FlightHumor.org](http://www.FlightHumor.org)

### Kitty Hawk, North Carolina

Get real on December 16 at the annual dinner of the Man Will Never Fly Society, this year held on the eve of the centennial celebration. Back in 1961, the society invited FAA Administrator Najeeb Halaby to attend. He declined, writing: "I wish you all a pleasant weekend, and I hope you won't be too disturbed by the sounds of men who share the illusion you so determinedly combat." [www.manwillneverfly.com](http://www.manwillneverfly.com)

### Dulles International Airport, Virginia

Be there on December 15 when the National Air and Space Museum opens the Steven F. Udvar-Hazy Center. Check its progress in the magazine's In the Museum section throughout the year. [www.nasm.si.edu/nasm/ext](http://www.nasm.si.edu/nasm/ext)

Keep checking the Calendar department of *Air & Space/Smithsonian* as well as our Web site throughout the year for notices of events. [www.airspacemag.com](http://www.airspacemag.com)



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## SIGHTINGS

**T**he airplane was an American invention, but as shown in these photographs from the L'Aérophile Collection, Library of Congress, it was the French who developed and refined it while the Wrights fought patent infringements. This explains why French words pepper the language of aviation—fuselage, aileron, longeron, empennage.

At Bagatelle, France, aircraft designer Henri Farman is surrounded after landing a Farman H.F.III in September 1910 (right). René Caudron soars past the Monaco Bay lighthouse in a Caudron-Fabré during the 1912 Hydroaeroplane Contest in Monte Carlo (below). Alberto Santos-Dumont (in derby at far right) leads a procession in Bagatelle in September 1906 that includes his airplane, *14-bis* (opposite, top). Georges Chemet is launched into the surf at Deauville in a Borel Hydravion during the 1913 Concours d'Avions Marins demonstration (opposite, bottom).





# Junkyard Wars: The Wright Brothers Challenge

*The Learning Channel  
Sunday, March 9, 2003*

The Learning Channel's weekly "Junkyard Wars," soon to enter its ninth season, describes itself as "the engineering contest of harebrained schemes, incredible tools, and lots and lots of duct tape." JW puts small teams of would-be Tim the Tool Man Taylors in a real junkyard and gives them a few days to assemble the surrounding junk into, say, a collapsible car, a submarine racer, a windmill, or a torpedo. To commemorate the upcoming 100th anniversary of the Wrights' first powered flight, JW invited three teams, from Britain, France, and the United States, to design and build a Wright brothers-era airplane, using tools from the early 1900s. To torque up the challenge, producers insisted that the teams complete the airplanes in just 48 hours, then fly their craft.

Vintage airplane builder Ken Kellett captained the American Eagles. He had built a replica of the 1903 Wright *Flyer* in 1978 and flown it 23 times, so he was familiar with the structural and mechanical aspects of early flying machines. Kellett decided on a 1911 Walden IX as the model his team would reproduce, but the only plans are in Kellett's head. Team members—his brother and two other enthusiasts—rely on his ingenuity to hatch an airplane out of old metal tubing, wood scraps, and cable.

"I fly but I don't know quite why I do it," British Buzzards captain Bill Brooks said to a camera. A micro-light designer



*Showing the flag: "Junkyard Wars" enlisted French, British, and United States teams to build vintage aircraft in two days—and then fly them (top). On Day Two, the French team makes a trial fit of the wing to their Blériot XI (above).*

and test pilot from Marlboro, England, he's made a previous appearance on "Junkyard Wars" building and flying a glider. Brooks' compatriots, including Wendy Phillips, a production manager at Pegasus Aviation and the only female on the teams, staked their British pride on a mongrel: Wright *Flyer* wings and a tail from a French Antoinette monoplane, tacked onto a fuselage whose origin is anybody's guess.

The French Falcons, meanwhile, were guided by Geraud Lafage, whose company produces and sells wood-and-fabric kit airplanes. His dream machine was modeled on the Blériot XI, the monoplane that in 1909 made the first aerial crossing of the English Channel. Aesthetics ruled: The French demanded beauty as well as function.

Later, speaking from a Pegasus hangar back home, Brooks said, "Three teams had different agendas. We refused to compromise on any structural integrity and flying performance. The French refused to compromise on anything that wasn't beautiful. And the Americans refused to compromise on authenticity."

Said Kellett, "I think we made history. I don't think anybody built an airplane in two days."

Who won the trophy for Best Flight? Just watch The Learning Channel on March 9.

—Robert G. Pushkar is a Boston-based writer and photographer with a special interest in aviation.



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# Apollo: The Epic Journey to the Moon

by David West Reynolds. Tehabi Books, Inc., 2002. 272 pp., \$35.00.

As a matter of theme, surrendering the Apollo program to historians as a mere weapon of the cold war is certainly a most drab and well-tried way to frame man's voyage to the moon.

Fortunately, David West Reynolds sees the Apollo missions in another context: the culmination of an ancient pursuit—an approach that allows him to infuse *Apollo: The Epic*

*Journey to the Moon* with an engaging sense of wonder, imagination, resourcefulness, daring, and magnitude.

Beginning with the visionary works of Jules Verne, filmmaker Fritz Lang, physicist Robert Goddard, and others, Reynolds documents from its foundations man's desire to set foot on our nearest neighbor. Wernher von Braun is cast as a figure who bridges the technological gap between the ideas of these pioneers and attainable reality and who, through magazine articles and a Disney-produced television series, vitalizes the U.S. space program.

The subsequent engineering challenges of Mercury, Gemini, and Apollo are documented with an unfailingly good-humored accessibility. When describing weight considerations that limited the lunar module's cabin hull to "a thickness of three sheets of aluminum foil," Reynolds remarks: "If the astronauts had been allowed to bring toothbrushes, the Grumman engineers would have cut the handles short to make them lighter."

Well-explained details distinguish the book. Reynolds reveals, for example, that during Apollo 17, damage to a fender on the moon rover threatened the astronauts' safety because it could have allowed heat-absorbing dust to coat their spacesuits. And he points out that when the astronauts devised a new fender from a laminated map and duct tape, they were "careful not to trap any oxygen underneath the tape, which would cause the tape to burst once they took it outside the LM."

Lunar missions are painstakingly illustrated with landing site diagrams, panoramic moon maps, and picture-book-size photographs that bring a real-time, three-dimensional understanding to the otherworldly travails faced by Apollo crew members.

Toward the end, the book loses some steam as it makes the transition from



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You can select the wind conditions, which sets up the runway configuration, or you can allow the program to select the winds by checking the "random" box in the wind menu.

Display adjustments are made through knobs or switches on the radar scope. The software responds to keyboard commands, but voice recognition software is also available. Keyboard commands are straightforward; DM = descend and maintain, and TL = turn left. An airport information menu, which can be accessed anytime, gives you the details you need to operate safely at the selected airport: field elevation, runways, holding patterns, departure exits, and aircraft characteristics. An arrival-and-departure tab list can be displayed on the scope, as well as flight progress strips.

The scenarios are limited only by your imagination. If an airport has only one runway with an instrument approach, poor weather conditions can be simulated and all the arrival aircraft must therefore use the instrument runway. This increases the degree of difficulty because you restrict the use of a visual approach to other runways (this is not a software option). Holding instructions can be issued, and you can practice working with holding situations.

Most scenarios build to peak traffic after a half-hour. Just when you think you've got it all under control, you get busier than, well, an air traffic controller.

The accompanying Web site, [atcsimulator.com](http://atcsimulator.com), has a thorough explanation of the program and links for air traffic control sites around the world.

—Gilbert B. Rhodes retired after four years as a U.S. Air Force air traffic controller and 32 years with the Federal Aviation Administration.



Apollo to Skylab and the shuttle program, but by then, of course, the space program had lost some steam itself.

—S.B. Goldberg is an associate editor at Air & Space/Smithsonian.

## More With Less: Paul MacCready and the Dream of Efficient Flight

by Paul Ciotti.

Encounter Books, 2002. 227 pp., \$26.95.

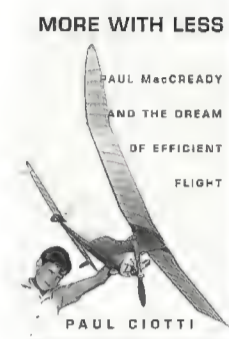
Aviation history is awash in the feats of tinkerers, adventurers, techno-geeks, and entrepreneurs, and while the name Paul MacCready may not come as readily to mind as Lindbergh or Rutan, he ranks among the giants of aviation innovators. His Gossamer Condor, winner in 1976 of the longstanding Kremer prize for the first human-powered airplane to complete a one-mile figure-eight course, hangs in the National Air and Space Museum.

A man who turned a love of airplane models and extreme soaring into a career creating radical designs for powered flight, MacCready has pushed the limits of "low and slow." From human-powered airplanes to "eternal" solar-powered airplanes to flying pterodactyls and ultra-lightweight gliders, MacCready has fashioned contraptions most thought were impossible.

Though MacCready is the central figure of the book, *More With Less* is really the story of a creative pursuit embodied in the vision and work ethic of MacCready, whose less-than-elegant, get-it-done working style is central to each project's success. Drawing primarily upon secondary sources, author Paul Ciotti traces these machines' evolution from concept to reality. He offers anecdotes and portraits of the diverse collection of talents and personalities needed to pull a project off, without getting bogged down in technical jargon. And he diverges into meditations on everything from man's innate desire to fly to the formation of high-altitude clouds to the impact of the 1970s oil crisis.

Though the practical applications of these cutting-edge vehicles may be dubious, *More with Less* remains a tribute to the kind of restless ingenuity that refuses to accept limits.

—Tom LeCompte is a pilot and freelance writer in Massachusetts.



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## The 11 Days of Christmas

by Marshall L. Michel III. Encounter Books, 2002. 325 pp., \$25.95.

Air combat veteran Marshall Michel III's *The 11 Days of Christmas* examines the late 1972 bombing of Hanoi and Haiphong in riveting, objective detail and offers a radical view of the still-controversial battle, which ended the Vietnam conflict. A portion of the book first appeared in this magazine's Dec. 2000/Jan. 2001 issue as "The Christmas Bombing."

By December 1972, the North Vietnamese had walked out of the Paris peace talks, Congress had threatened to cut funding for the war, and the anti-war movement was at its zenith. President Richard Nixon decreed a massive bombing of North Vietnam, believing that raids using the mighty B-52s could bring an end to the war.

The Strategic Air Command took both strategic and tactical control of the operation, setting in motion a dreadful turf battle. Drawing on interviews with B-52 crews and their commanders, plus a surprising number of North Vietnamese sources, Michel paints a picture quite at variance with rosy U.S. Air Force histories of the action. Yet the peace talks did resume and the war did end. Even so, North Vietnam still reveres the battle as the "Dien Bien Phu of the Air." We learn why both sides are not entirely wrong. Or right.

Michel's day-by-day account is compelling and his conclusions are convincing—whether the reader is taken aboard a wounded B-52 or inside a Hanoi surface-to-air-missile command center. SAC crews displayed courage as they engaged in suicidal tactics dictated by SAC staff in Omaha, Nebraska, and the reader gains a new appreciation for the intelligence, cleverness, and above all flexibility of the North Vietnamese missile command.

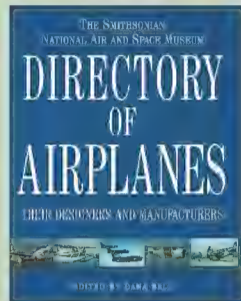
Michel, who flew 321 missions, some during the action he examines, has done a valuable service for his fellow airmen as well as historians.

—William Jeanes lives in Pass Christian, Mississippi, and is a former editor-in-chief of Car and Driver.



## REFERENCE

**The Smithsonian National Air and Space Museum Directory of Airplanes: Their Designers and Manufacturers**, edited by Dana Bell. Greenhill Books, 2002. 352 pp., \$49.95.



The latest must-have from the National Air and Space Museum, this exhaustive volume lists 25,000 airplane types organized by their 5,000 designers and manufacturers in an attempt to identify, for the first time, every airplane manufacturer and designer and every airplane ever produced. Entries are cross-referenced, and brief company histories enable you to track mergers and name changes. Not covered: balloons, dirigibles, missiles, rockets, spacecraft, or those shameful vehicles trying to masquerade as real airplanes: drones and unmanned aerial vehicles. This is an airplane's book of airplanes, the alpha-male of aviation references.

## Gunther Rall: A Memoir

by Jill Amadio. Tangmere Productions, 2002. 304 pp., \$28.95.

Gunther Rall is a remarkable man. With 275 victories, he is the third-highest-scoring pilot in the history of air combat. As a Luftwaffe ace, he flew Bf-109s from 1939 until Germany was defeated in 1945 and was one of the few pilots to fly the Me 262 twin-engine jet, though never in combat. Jut-jawed and as jaunty as his 50-mission crush cap, he could have been sent from Central Casting to play a "German nobleman fighter pilot" in any war movie, though he was in fact the son of a middle class merchant.

Rall spent the years immediately following the war as a clerk and traveling salesman, yet ultimately became the chief of staff of the new German air force and a NATO general. He was the first German pilot to fly the Lockheed F-104, which the Luftwaffe adopted largely at his urging—unfortunately, as it turned out; for pilots and technicians who had been grounded for over a decade, the F-104 was a handful to fly and maintain.

You'll search fruitlessly for technical errors of any consequence—perhaps in part because Amadio's father had been a Royal Air Force Short Stirling pilot, and also because the National Air and Space Museum's Don Lopez played a strong role in the editing. All told, the depth, detail and robustness of Jill Amadio's research into Rall's life is astounding.

—Stephan Wilkinson is a contributing editor to Air & Space/Smithsonian.



## American Military Aviation: The Indispensable Arm

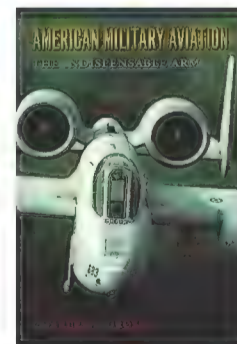
by Charles J. Gross. Texas A&M University Press, 2002. 416 pp., \$35.00.

This thoroughly indexed and annotated volume represents a history collected from secondary sources, and it takes in a wide sweep, missing only the conclusion of the joint U.S. forces air campaign in Afghanistan, which apparently occurred after the book was completed.

Gross' primary focus is doctrine: the "handbook" of missions and rules that guides all U.S. air forces through various eras, from the obsession with Billy Mitchell-style saturation bombing (nobody calls it "precision" anymore) to the current "global reach, global presence" mantra that echoes the expeditionary air force concept developed by the British Royal Air Force.

Inter-service rivalries punctuate this history, which concludes that air power is necessary when a nation sets out to use military force in pursuit of its interests (if not always in defense of them). Gross argues that air power can be a highly effective force, but too many proponents have over-promised what it can deliver.

Gross tips his hat to the Reserve and Guard, the voluntary deployments of which have allowed presidents to duck the politically messy business of activating them, as we are reminded several times. As chief of the Air National Guard history program, Gross can be forgiven that preoccupation. —George C. Larson is the editor of Air & Space/Smithsonian.



*"Saving and remembering these aircraft — now that's a good cause..."*



Photo: Eric Long

**"Besides all the aircraft during the War, I got to work on the first jets ever built. I think I even pulled an engine on an aircraft or two hanging in this Museum!"**

**— ANTON C. LOVE**

Retired flight engineer Anton Love is front of the Supermarine Spitfire Mk. VII and his favorite airplane engine, the Rolls Royce Merlin, now on display in the World War II Aviation Gallery in the National Air and Space Museum.

Preserving the vast history of flight is the mission of the National Air and Space Museum. It's a powerful cause, and Anton C. Love believes in it strongly.

A retired aircraft mechanic and senior flight engineer, he reckons he worked on just about every type aircraft flown in his time, from fighters during World War II to the Douglas DC-4 in the 1950s. He wants them all to be remembered, and that's why he's established two charitable gift annuities to benefit the Museum.

If you'd like to help the National Air and Space Museum with a gift of lasting significance, fill out and return the reply form below, or call 202-357-2493. You may also e-mail [gayle.union@nasm.si.edu](mailto:gayle.union@nasm.si.edu). Preserve aviation history!

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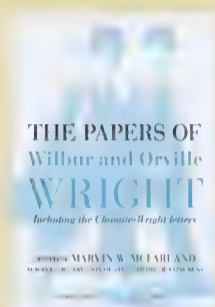
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A&S 03 03

Hundreds of works cover the Wright brothers' early life, process of discovery and invention, career, and legacy.

**The Bishop's Boys: A Life of Wilbur and Orville Wright** by Tom D. Crouch, W.W. Norton & Company, 1989. Written with reverence and encyclopedic knowledge by a National Air and Space Museum curator.

**The Wright Brothers: Heirs of Prometheus** by Richard P. Hallion, Smithsonian Institution Press, 1979. Air Force historian Hallion compares the Wrights to some of the greatest inventors of the ages.



**The Papers of Wilbur and Orville Wright, Including the Chanute-Wright Papers, Volumes 1 and 2, by Orville and Wilbur Wright**, edited by Marvin W. McFarland. McGraw-Hill Professional Publishing, 1953. Reprinted in 2001.

This bound and boxed set has been reissued to commemorate the centennial of powered flight. Wright scholar McFarland assembled the Wrights' diary entries, 235 drawings and illustrations, and aeronautical and personal correspondence in this comprehensive treasure.

**The Wright Brothers: A Biography** by Fred C. Kelly, Harcourt, Brace and Company, 1943. Reprinted by Dover Publications, 1989. A newspaperman and friend to the Wrights, Kelly provides an Orville-authorized account of Wright accomplishments as well as controversies.

**Wright Reminiscences** by Ivonette Wright Miller, the Air Force Museum Foundation, Dayton, Ohio, 1978.

Ivonette Wright Miller reflects on her Uncles Orv and Will, with endearing anecdotes about early Wright family life (see "Meeting Wilbur and Orville," p. 28).

**Wilbur and Orville Wright: A Chronology Commemorating the Hundredth Anniversary of the Birth of Orville Wright** by Arthur George Renstrom, Library of Congress, 1975. A reference of milestones in the Wrights' lives.

**How We Invented the Airplane: An Illustrated History** by Orville Wright, edited by Fred C. Kelly. Dover Publications, 1989. Kelly draws on his three decades as confidant and authorized biographer to the Wrights, adding his insight to the brothers' writings.



**Miracle at Kitty Hawk: The Letters of Wilbur and Orville Wright**, edited by Fred C. Kelly, Farrar, Straus & Giroux, Inc., 1951, reprinted 1996, DaCapo Press.

A volume of selected correspondence with family members and others recounts the first flights.

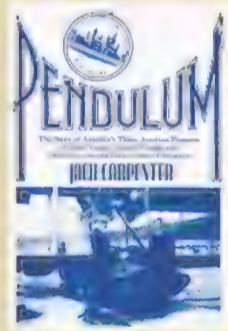


**The Wright Brothers' Engines and Their Design** by Leonard S. Hobbs, Smithsonian Institution Press, 1971. A technical but readable work on the Wright approach to things mechanical.

**Visions of a Flying Machine: The Wright Brothers and the Process of Invention** by Peter L. Jakab, Smithsonian Institution Press History of Aviation Series, 1990, reprinted 1997. NASM curator Jakab presents the Wrights as dreamers with practical grit.

**Pendulum: The Story of America's Three Aviation Pioneers—Wilbur Wright, Orville Wright, and Glenn Curtiss, the Henry Ford of Aviation** by Jack Carpenter. ABC/Jack Carpenter.

In Carpenter's telling, Curtiss can do no wrong in vitriolic disputes with the Wrights about patents and due credit, and the Smithsonian is the henchman in a cover-up of the Curtiss legacy.



**Wilbur and Orville: A Biography of the Wright Brothers** by Fred Howard, Dover Publications, 1998.

The definitive study of the Wrights, from their early fascination with flight to design of the Flyer, through the bitter patent fights, Wilbur's early death, and Orville's later years.

**The Wright Brothers: From Bicycle to Biplane** by Fred C. Fisk and Marlin V. Todd. Miami Graphics Services, 1990. Order from the Museum Store at Carillon Park, Ohio, <http://www.carillonpark.org/onlineorderform.htm>. Reflections on the practical workshop experience of the Wrights.

**Kitty Hawk and Beyond: Wright Brothers and Early Years on Aviation: A Photographic History** by Ronald Geibert and Patrick B. Nolan. Kampmann National Book Network, Wright State University Press, 1990. Geibert and Nolan present many familiar photographs and some rarely seen.

## FOR KIDS

**The Wright Brothers: How They Invented the Airplane** by Russell Freedman, Holiday House, 1994.

Freedman's engaging narrative appeals to 12- to 18-year-olds while being technically accurate. Includes diagrams and lucid explanations of the principles of problem-solving the Wrights favored.



**First Flight: The Story of Tom Tate and the Wright Brothers** by George Shea, illustrated by Don Bolognese, HarperCollins Juvenile Books, 1997. From the "I Can Read" Chapter Book Series, this is the fictional story of Tom Tate, a boy from Kitty Hawk who befriended Orville and Wilbur Wright and took the second solo flight on their first glider.

**Taking Flight: The Story of the Wright Brothers** by Stephen Krensky, illustrated by Larry Day. Simon & Schuster Ready-To-Read series (ages four to eight), 2000.

Krensky tells the Wright tale in language suitable for parents to read to small children. The paintings by Day and excerpts from the Wright letters add personality.



**Airborne** by Mary Collins, illustrated by Jo Tunstall. National Geographic, available April 2003.

A photo-biography of Wilbur and Orville Wright for young adults.



**To Fly: The Story of the Wright Brothers** by Wendie C. Old, illustrated by Robert Andrew Parker, Clarion Books, 2002. Recounts the Wrights' experiments and childhood

fascination with kites and gliders, and shows how Orville was the idea man and Wilbur the problem-solver.

## FOR BIG KIDS: Video

**The Wrong Brother**, a short film by Chris Bowman. Downloadable in Quicktime format from <http://www.ldsfilm.com/short/WrongBrother.html>, or use that link to order from Candle Light Media.

A short comedy made by Chris Bowman while a film student at Brigham Young University, this film tells the fictional story of Hector Wright, the less famous Wright brother.

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## CALENDAR

### February 1

Monthly Special Event: "Tuskegee Airmen." This event will feature several Tuskegee veterans, the first official combat pilots of African-American heritage. Planes of Fame Museum, World War II CAL-AERO Field, Chino, CA, (909) 597-3722, [www.planesoffame.org](http://www.planesoffame.org).

### February 8

U.S. Air Force Band of Flight Concert: "Hearts, Heritage, and Heroes." U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704, ext. 330.

### February 22

Seminar: "Afghani Adventures—A Remembrance of War." U.S. Air Force B-1B pilots describe their role in fighting the war on terrorism. American Airpower Heritage Museum, Commemorative Air Force Headquarters, Midland, TX, (915) 563-1000, ext. 2259.

### February 27

Lecture: "Lessons for Airmen From the Kosovo and Afghanistan Experience" by Lieutenant General Michael C. Short, USAF (ret.). U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704, ext. 330.

### March 7—9

Valiant Air Command's Tico Warbird Airshow. Titusville, FL, (321) 268-1941.

### March 12 & 13

General Aviation Maintenance Seminar. Lewis University, Romeoville, IL, (217) 785-8516.

### March 20—22

International Women in Aviation Conference: "Celebration of Flight—Saluting the Past, Embracing the Future." Cincinnati, OH, (386) 226-7996, [www.wiai.org](http://www.wiai.org).

### March 22

Seminar: "Leading From the Front." Admiral Martin Carmody, U.S. Navy (ret.), talks about his career, from flying dive bombers to commanding a carrier division during the Vietnam War. American Airpower Heritage Museum, Commemorative Air Force Headquarters, Midland, TX, (915) 563-1000, ext. 2259.

*Organizations wishing to have events published in Calendar should fax press releases two months in advance to (202) 275-1886 or mail them to Calendar, Air & Space/Smithsonian, MRC 951, P.O. Box 37012, Washington, DC 20013-7012.*

## CREDITS

**One Very Cold War.** Paul R. Cochran flew P-47s and P-51s with the U.S. Eighth Air Force in England during World War II; he also served during the Korean War. After retiring from the Air Force, he managed a general aviation airport. Presently, he is a docent at the National Air and Space Museum.

**Figured Out.** S.B. Goldberg is an associate editor at *Air & Space/Smithsonian*.

**Meeting Wilbur and Orville.** Tom D. Crouch is a curator at the National Air and Space Museum's department of aeronautics and a historian who specializes in the Wright brothers.

**The Original.** Peter L. Jakab is curator of early flight and World War I aviation at the National Air and Space Museum. He has written three books and numerous articles on the Wright brothers and the invention of the airplane, and is curator of the Museum's upcoming centennial of flight exhibition, "The Wright Brothers & the Invention of the Aerial Age."

**The Wright Fleet.** While researching the Wright brothers for this assignment, illustrator Paul DiMare, an Ohio native, was impressed by their "cool, scientific approach—always learning from their mistakes." DiMare now vows to visit Kitty Hawk.

### How Things Work: The 1903 Wright Flyer.

Phaedra Hise is a freelance journalist, author, and private pilot who is under the 140-pound weight limit for piloting a 1903 Wright *Flyer* replica. Any takers?

**"I Have Today Seen Wilbur Wright and His Great White Bird."** Mary Collins is a consulting editor at *Air & Space*.

**Defining Moments.** Roger Bilstein is an educator, historian, and author. He wrote *Flight in America: From the Wrights to the Astronauts*, the third edition of which was published by Johns Hopkins University Press in 2001.

**Wrong Turns.** T.A. Heppenheimer's book *Turbulent Skies: The History of Commercial Aviation* (John Wiley & Sons, 1998) was the basis for the PBS television series "Chasing the Sun."

**10 Great Pilots.** Patricia Trenner is the senior editor at *Air & Space* and a decidedly ungreat pilot.

**10 Milestone Flights.** Perry Turner is the senior associate editor at *Air & Space*.

**Aviation's Birth Certificate.** Douglas Gantenbein is the Seattle correspondent for *The Economist*.

**100 Ways to Celebrate 100 Years of Flight.** Roger A. Mola, who also writes for *Airshows*, is busy thinking up more ways to observe the centennial.

## FORECAST

### In the Wings...

#### The Hughes Racer Flies Again

It was the sultan of sleek. In the early 1930s, when Thompson Trophy racers were just beginning to nibble at 300 mph, Howard Hughes designed himself a speedster. He set a speed record in it in 1935 (352.38 mph) and two years later flew it on a record-breaking transcontinental dash. The one-of-a-kind Hughes H-1 became a two-of-a-kind last July, when Jim Wright flew his new Racer reproduction, as beautiful a handmade airplane as the original on display in the National Air and Space Museum.

#### How the 747 Got Its Hump (and other stories)

Finally, an explanation for those curious family resemblances among airplanes.

#### The U.S. Army's Flying Saucer

It looked like it came from another planet, but in fact it came from Canada. The Avrocar posed a bigger threat to its test pilots than to the enemy it was designed to battle.

#### A Faith-based Search for Planets

Are there Earth-like planets orbiting other suns? Can detectors be made precise enough to find them? A spacecraft to be launched into heliocentric orbit in 2007 has made Bill Borucki a believer.



WAYNE SAGAR

*Hubba hubba: A copy of the Hughes H-1 racer will hit the airshow circuit this season.*

#### Our Germans Were Better Than Their Germans

So influenced was U.S. space exploration by Wernher von Braun and the German engineers who came with him, that the Soviets credited them with winning the space race for the United States. But German rocket scientists were also taken to the Soviet Union after the war. Their experiences, in stark contrast to those of their

counterparts who went to the West, shed new light on the Soviets' accomplishments in space.

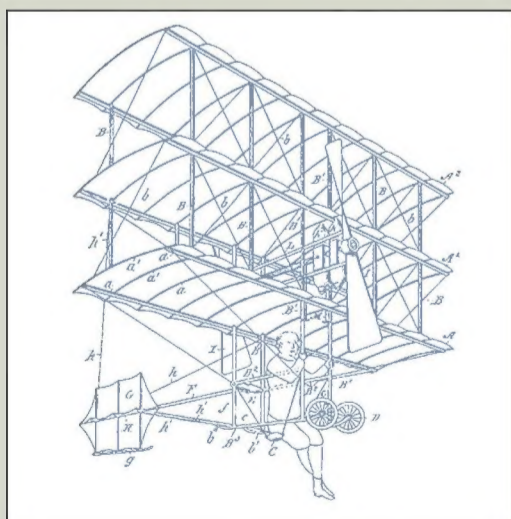
#### The Doomsday Mission

One chilling strategy for fighting World War III was a method of dropping small nuclear weapons on Soviet targets. We tell how a handful of pilots developed the tactic known as "the idiot loop."

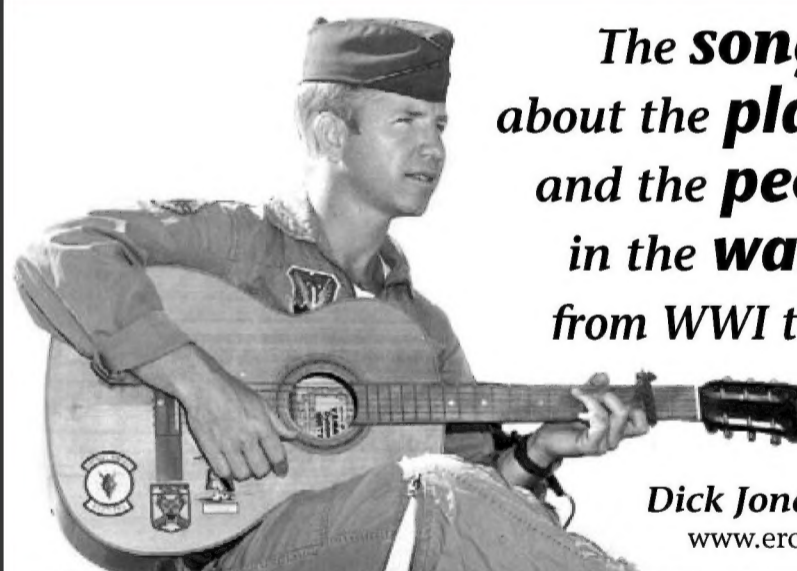
## ON THE WEB SITE

### www.airspacemag.com

With each issue, we post on the *Air & Space* Web site information to supplement the features in the magazine. To pursue the suggestions in our guide to celebrating the centennial of flight (pp. 80–88), visit our Web site, where you can click on URLs listed in the guide, a more convenient way for you to get to a site of interest.



*Patent drawing, 1896 Chanute-Herring glider. Find it through a link on www.airspacemag.com.*



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# 1902: Going Back to Camp

For the next six issues, Moments & Milestones will present glimpses of the Wrights' lives as the brothers moved toward their historic flight in 1903. In this correspondence, from *The Papers of Wilbur and Orville Wright, Volume One, 1899-1905* (McGraw-Hill, 2001), we get a look at the progress the brothers have made and see them complete the 1902 machine.

*Katharine Wright (the Wright brothers' sister) to Milton Wright (their father), September 25, 1901:*

"We had a picnic getting Will off to Chicago. Orv offered all his clothes, so off went 'Ullam' arrayed in Orv's shirt, collars, cuffs, cuff links and overcoat. We discovered that 'clothes do make the man' for you never saw Will look so 'swell.' Mr. [Octave] Chanute entertained him at his house and took him up into his study which Will declares was ten times dirtier and more 'cluttered' than yours ever was.... It seems that he has models of flying machines suspended from the ceiling so thick that you can't see any ceiling at all."

*Wilbur Wright, "Some Aeronautical Experiments," delivered to the Western Society of Engineers, Chicago, September 18, 1901:*

"...we proceeded in the summer of 1900 to Kitty Hawk, North Carolina, a little settlement located on the strip of land that separates Albemarle Sound from the Atlantic Ocean. On the very day that the machine was completed the wind blew from 25 to 30 miles per hour, and we took it out for trial as a kite.

"Everything seemed to us to confirm the correctness of our original opinions: (1) that practice is the key to the secret of flying; (2) that it is practicable to



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*Katharine Wright, Wilbur and Orville's sister and best friend, watches them work.*

assume the horizontal position; (3) that a smaller surface set at a negative angle in front of the main bearing surfaces, or wings, will largely counteract the effect of the fore and aft travel of the center of pressure; (4) that steering up and down can be attained with a rudder, without moving the position of the operator's body; (5) that twisting the wings so as to present their ends to the wind at different angles is a more prompt and efficient way of maintaining lateral equilibrium than shifting the body of the operator."

*Katharine Wright to Milton Wright, Dayton, Ohio, August 20, 1902:*

"...Will and Orv...are talking of going [to Kitty Hawk] next Monday.... They really ought to get away for a while. Will is thin and nervous and so is Orv. They will be all right when they get down in the sand where the salt breezes blow, etc. They insist that, if you aren't well enough to stay out on your trip, you must come down with them. They think that life at Kitty Hawk cures all ills, you know.

"The flying machine is in process of making now. Will spins the sewing machine around by the hour while Orv squats around marking the places to sew. There is no place in the house to live but I'll be lonesome enough by this time next week and wish that I could have some of their racket around...."

## LOGBOOK

### Events

Check NAA's Web site, [www.naa-usa.org](http://www.naa-usa.org), for details on the annual Spring Awards Ceremony for 2003. Don't miss the opportunity to be part of the events that will take place in the 100th anniversary year.

The 2002 Robert J. Collier Trophy will be presented at a dinner on June 10, 2003, at the Crystal Gateway Marriott in Arlington, Virginia. The Collier Trophy is awarded annually "...for the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency, or safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

### Nominations

Nominations for the 2003 Katharine Wright Memorial Award will be accepted through March 31, 2003. The award is presented to a woman who has "provided encouragement, support and inspiration to her husband and was instrumental in his success; or made a personal contribution to the advancement of the art, sport and science of aviation and spaceflight over an extended period."

Nominations for the 2003 Harmon Aeronaut (Ballooning) Trophy will be accepted from April 15 to July 15, 2003. The trophy is awarded each year "for the most outstanding international achievement in the art and/or science of aeronautics (ballooning), with the art of flying receiving first consideration."

Nominations for the Cliff Henderson Award for Achievement will be accepted through April 30, 2003. It is presented annually "to a living individual or group whose vision, leadership or skill has made significant and lasting contribution to the promotion and advancement of aviation or space activity."

Moments & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at [www.naa-usa.org](http://www.naa-usa.org) or call (703) 527-0226.